ERRATA.

Page 143, line 6 from bottom, for *Rhinoceros* read *rhinoceros*.

Page 191, line 6 from bottom, for *Sindora wallichii* Benth. read *Sindora supa* Merr.

Page 195, line 18, for *grandiflnus* read *grandiflorus*.

Page 19[illegible], line 25, for order read genus.

Page 200, line 34, exclude the *Dipterocarpus* tree, and substitute *Anisoptera* [illegible] Brandis (*Dipterocarpaceæ*).

Page 201, line 9, for *Dipterocarpus anisoptera vidaliana* read *Anisoptera vidaliana* Brandis (*Dipterocarpaceæ*).

Page 984, No. 28, line 5, for 996 read 995.

Page 984, No. 32, line 16 from bottom, for 995 read 996.

Page 991, line 2, for CHAMBERLAIN read CHAMBERLAINI.

For other errata see page 226.

THE PHILIPPINE

JOURNAL OF SCIENCE

VOL. I JULY, 1906

RINDERPEST.

By PAUL G. WOOLLEY.

(*From the Serum Laboratory of the Bureau of Science.*)

INTRODUCTION.

Since the earliest days of American occupation in the Philippine Islands, rinderpest has claimed the attention of the Government. Its ravages and the progressively increasing losses it had caused to the industrial community, made the subject so important a one in relation to the welfare of the Islands that soon after the organization of the Government a laboratory was established to prepare serum in quantities sufficient to control and, if possible, to eradicate the disease.

In the first years of this work, when non-immune cattle were more easily secured, the opportunities for experimental work on this subject were circumscribed, because of the limited number of workers, the labor entailed in the inoculation of serum animals and in the preparation of serum, the lack of small animals, and of the apparatus for exact experiments. Such work as was done was performed by Jobling and published as a bulletin of this Bureau.[1] Since the organization of the laboratory has been completed, the use of protective inoculation against rinderpest has become more general in the Philippine Islands with the result that it has been difficult to secure animals which were certainly susceptible to this disease and for this second reason the more recent

[1] *Publications Serum Laboratory, Bureau of Government Laboratories* (1903), 4, and *Annual Reports of the Superintendent of Government Laboratories* (1903, 1904), 2, 3.

experimental work has also been curtailed. However, within the past two years two regions in the Islands where cattle are obtainable and where rinderpest has never been observed, have been discovered, namely, Sibuyan Island and the Babuyanes group, and from these islands relatively non-immune animals have been secured for use although, even with these sources of supply, such a large quantity of virulent blood has been required for the production of serum, and the expense of experimentation with cattle has been so great, that the material available for investigation has been small. Nevertheless, some work has been done and some observations made which seem to be of sufficient interest to publish, even though they do not in all ways tend to support the prevalent opinions of the nature of the virus.

ETIOLOGY.

Rinderpest is a widely distributed disease. The original location from which the infection has spread will doubtless never be ascertained, for although European historians of the middle ages mention similar infections, no evidence exists of accurate observations in Asia or Africa in early times. Dieckerhoff's treatise on the history of the disease details what is known in regard to its early occurrence, from which it seems probable that its original home was in the neighborhood of the Black Sea and of the Volga, whence, in the course of years, it was introduced into western Europe; following this, Prussia and the Danube States, Hungary, Croatia, and Italy were attacked; Switzerland, France, Holland, and England remaining free. Later still, with the appearance of railroads and the possibility of rapid transportation, epidemics became common in western Europe, and even England, Germany, and France suffered severely. With the opening of Africa, India, China, and the islands of the Eastern Archipelago, the disease was also observed in this portion of the world and likewise introduced into virgin lands, so that in the many parts of Africa, Asia, certain islands of the Malay Archipelago and most of the Philippine islands, rinderpest is endemic and subject to sudden outbreaks. Climate undoubtedly has little influence on its spread. It does not "give way before cold weather or rain;" it is, Gelach and Littlewood say, more severe in cold and wet weather than in warm and dry and Emes maintains that "it spreads as fast in a cold as in a hot season."

However, moisture surely has an influence on both the viability of the virus and the spread of the infection so that moist or rainy seasons undoubtedly favor the dissemination of the disease.

Gamgee states that age exerts no influence on the susceptibility of an animal to rinderpest and quotes Kersting as saying that, as a result of inoculation, young calves and cows suffer most severely; lean or fat oxen are also badly affected, while animals in moderate condition and at

maturity appear to possess a greater resistance against the disease. These statements do not seem to us to be strictly applicable to cattle in the Philippine Islands. Our experience has taught us that calves are satisfactory subjects for immunization, that milch cows or pregnant animals are less so, and that maturity plays no part in susceptibility. Sex has no influence, if the physical condition of the animal is normal.

Natural resistance, immunity, and susceptibility.—Rinderpest is a disease of cattle and of some allied ruminants.

Man is immune, as are cats, dogs, donkeys, rabbits, guinea pigs, rats, mice, doves, hens, eagles, flamingoes, etc. (Koch, Nicolle and Adil-Bey, Tokishiga, and Tartakowsky.) Sheep and goats are not completely immune, but they have a natural resistance to the disease. However, in these animals as in others, there are racial differences. Both species may show a rise of temperature after experimental inoculation and if the blood is drawn at this time and used to inoculate non-immune cattle, the disease may be produced. (Kolle and Turner, Koch, Theiler and Pitchford, Woronzow.) Sheep may be the means of spreading contagion as Koch and Rogers have stated.

Hogs, camels, antelopes and buffaloes are not so highly susceptible though any of these *may* have the natural or artificial disease.

Natural infection of hogs has been reported from Tonkin and Annam by Clive and Fraimbault. Tartakowsky, in opposition to Refik-Bey, states that camels are sensitive in a certain degree, but that they usually resist the disease or only show mild symptoms. Mense, from his observations, concludes it to be possible that buffaloes may die in large numbers, though Nencki and his fellow-workers say that they are less susceptible than cattle. However, there is not only the difference in immunity of species but there are racial differences of susceptibility and resistance.

In India, Rogers and Lingard found the hill cattle so susceptible that the usual methods of immunization used in the case of animals from the plains were of little avail with the former. These differences, as Sobernheim suggests, may be a result of the endemic occurrence of the disease which, in the course of time, has given rise to incomplete resistance but not to an inborn racial immunity. Kolle has observed in the Soudan, and Pinching and Bitter in Egypt, that the cattle of those localities have a very slight, whereas those of South Africa have a uniform susceptibility.

In the Philippines the variation is so great that, save in a few islands, it can not in advance be stated without further experimental evidence, whether the cattle are susceptible or not. In the Babuyanes group and in Sibuyan, rinderpest has never been experienced, but nevertheless there is an apparent relative resistance to infection in the cattle from these places. The same is true of the animals from certain parts of Australia. The susceptibility of American stock seems to be very great. We have had a very bitter experience with such animals and have found the usual methods of immunization, which are perfectly safe with Philippine cattle, to be extremely dangerous when applied to the former.

In this Bureau we have performed some experimental work in the study of the immunity or susceptibility of laboratory animals.

A series of guinea pigs was inoculated with 0.5 cubic centimeter each of virulent rinderpest blood. Three to four days later they showed increased temperature which continued for twenty days. On the second and third days of the fever, blood was drawn from them and injected into Babuyanes cattle with the result that none of the latter sickened, although all showed a reaction. Later inoculation of the cattle with 5 cubic centimeters of virulent blood showed none to have any appreciable degree of immunity.

The attempts to discover and isolate the organism.—In rinderpest, as in all other of the diseases the etiology of which is not known, many observers have described organisms believed by them to be the active cause of the infection. Thus, Metschnikoff and Gamaleia constantly found in the ulcers of the fourth stomach of sick animals, but not constantly in the blood, bacilli which caused symptoms of rinderpest in guinea pigs and calves. Simpson, Edington, Blin and Carongean, Saccharov, Sadowski, Konew and Trofinow, Semmer, Nencki, Sieber and Wysnikiewicz, and Nencki and Sieber, have described other bacteria, but none of these have been proved to be the causative factor.

The virus of rinderpest.—The etiologic factor is at the present time unknown in spite of conscientious labors of the best workers, extending over a period of many years. However, it is certain that the infecting agent is contained in the secretions of the nasal passages, conjunctivæ, intestines, and in the blood of infected animals, for with any one of these the disease can be reproduced in other individuals. The most certain method of conveying rinderpest is by the injection of infected blood. In using the latter it has been said that 1/500 is just as effectual in producing the disease as is 1 cubic centimeter and that with the former amount, non-immune animals may be killed. (Koch, Kolle, Turner, Nicolle, and others.) From our observations we are able to confirm this dosage only in the cases of cattle which may be called absolute non-immunes, as are the American cattle which we have used. With native animals even from the above-mentioned non-infected islands, this minimal dosage results in a variable incubation period and a diminished intensity of the disease. Some of these cattle, but not all, would probably die if infected with such a minimal dose, but in some instances even 0.1 cubic centimeter of virulent blood will not produce the disease and also the incubation time is noticeably shorter after a dose of 5 than after 1 cubic centimeter, yet the cattle from these Islands are certainly non-immunes. (See cases, Chart 5, No. 931, and Chart 2, No. 907.)

The viability of the virus.—The virus of rinderpest from the blood or the animal secretions mentioned above possesses little viability. Left at a fairly warm room temperature it soon becomes inactive; it retains its activity longer when it is placed on ice, but even under these circumstances the period is not very great. The length of time during which it may be kept in a viable condition varies, according to reports, between three and thirty-two days, but our experience

indicates a limit of from three to six. Kept at 36° to 40° C. it becomes inactive after two days (Theiler); dried blood may remain virulent for four (Koch); glycerine, phenol, and other antiseptic substances, even if used in minute amounts, cause rapid deterioration (Koch, Theiler, Semmer); if it is mixed with other organisms it is quickly killed. The virus resists alkalies longer than it does acids (Nicolle and Adil-Bey); sun destroys it in five minutes (Braddon), but ordinary daylight has little effect (Woronzow and Eckert). Semmer states that material will remain virulent during four to six weeks at ordinary temperatures and that a spleen kept on ice was still capable of causing the disease after six months. At 58° to 60° the virus loses its power in a few seconds, at 52° in half an hour, and at 37° to 45° C. there is a gradual loss. *In vacuo* the deterioration is still more rapid (Nicolle and Adil-Bey). Semmer makes the statement that the virus, heated to 45° to 50° C. during fifteen to thirty minutes, loses its virulence but will give a stable and lasting immunity. On the other hand, Nicolle and Adil-Bey found that blood heated to 60° C. lost its power of carrying the infection and would then not confer immunity. Semmer also states that a temperature of −20° C. brought about an attenuation and Nicolle and Adil-Bey found that blood kept in the cold for two months had lost all virulence.

Dilution with different substances gives varying results. Virulent blood mixed with glycerine becomes inactive (Koch). Nicolle and Adil-Bey found that 1/60 cubic centimeter of virulent blood diluted with 1.5 cubic centimeters of normal saline solution was capable of transmitting the infection, but if a like amount of the former was added to 500 of the latter, the virulence was lost. Virulent blood mixed with normal bile or bile salts retains none of its activity (Aduni).

Purely physical processes may also have an effect. It is said that centrifugalized blood does not cause the disease (Kolle) and that defibrinated blood will give a temporary immunity (Rogers).

Experiments on filtering virulent blood.—The results attained by experiments on filtration vary. Nicolle and Adil-Bey state that the organism passes normal Berkefeld and Berkefeld *aminoic* filters and *Yersin found that the filtrate obtained by passing rinderpest blood through Chamberland F candles would cause the disease.* On the other hand, Nicolle and Adil-Bey say that the organism does not pass a Chamberland F and Yersin says a Chamberland B gives an inactive filtrate.

Our experiments are as follows:

In 1905, four animals were chosen from a herd of native nonimmunes (Sibuyan). One of these (Chart 1, No. 905) was used as a control and received no blood, but was kept under exactly the same conditions as the others; another (Chart 2, No. 907) was used as a blood control and received 1 cubic centimeter of virulent blood, diluted with 5 cubic centimeters of an 0.8 per cent saline solution; a third (Chart 3, No. 908) was given 5 cubic centimeters of a filtrate from virulent blood, which was collected by passing through a Pasteur-Chamberland F candle, under a pressure of 1.75 kilograms per square centimeter and then diluted with 5 volumes of the same salt solution; a fourth animal (Chart 4, No. 904) received 100 cubic centimenters of the unfiltered blood used for No. 3. The first bull had a normal temperature during twelve days, at the end of which time it was inoculated with 60 cubic centimeters of virulent blood; it then reacted on the third day and was bled to death three days thereafter; at autopsy typical lesions of rinderpest were present. The second animal showed a reaction on the seventh day and a post-mortem made some days later gave convincing proof of the presence of the disease. The third one reacted mildly on the ninth day; three days subsequent thereto 60

cubic centimeters of virulent blood were injected, the result being that a typical reaction was observed on the second day, followed by death two days later. At autopsy, typical, but advanced, lesions were observed. This result seemed to indicate that the disease was caused by the filtrate, so that, had the larger dose of blood not been used, the animal might have recovered. The fourth bull suffered a typical attack of rinderpest.

The conclusion must be drawn from these experiments that small doses of blood or filtrate were not satisfactory with the cattle we used because, as was indicated above, their natural resistance is a great one. For this reason the quantities were increased in later experiments.

In the next series fresh, citrated virulent blood was diluted with five times its own volume of a 0.4 per cent saline solution and then filtered through a new, sterilized Pasteur-Chamberland bougie, under a pressure of 3 kilograms per square centimeter. Two native (Sibuyan) cattle received 30 cubic centimeters each of the filtrate and a control animal was given, subcutaneously, 5 cubic centimeters of the undiluted blood. On the fourth day after inoculation, the control (Chart 5, No. 931) developed the disease; it was subsequently bled to death and the diagnosis established. One of the others (Chart 6, No. 938) had a rise in temperature on the seventh day, was bled to death three days later and the diagnosis of rinderpest confirmed; the second one (Chart 7, No. 937) reacted on the eleventh or twelfth day and developed diarrhœa on the fourth day thereafter, whereupon it was bled and the diagnosis of rinderpest made.

These cases, in view of our other experiences with small amounts of virulent blood and delayed reaction, seem to suggest the virulence of the filtrate. It should be added that the animals were kept under similar conditions in regard to their food and environment but that the control was separated from the other two animals by a distance of approximately two miles and that no one in attendance upon the one had any access to the others. In addition, ten other non-immune cattle which did not contract the disease were stabled with the animals receiving the filtrate, so that their quarters had not become infected.

A third series was as follows: An animal received 30 cubic centimeters of filtrate from a Chamberland 1 candle (3 kilograms pressure per square centimeter). A reaction was observed on the tenth day but on the third one thereafter the temperature again was normal. After receiving 5 cubic centimeters of virulent blood, this bull showed a typical reaction, developed rinderpest, and died.

Apparently, to judge from these results, the causative agent of the disease may or may not pass through the pores of the Pasteur-Chamberland filter according to the conditions surrounding the experiment. More work on this subject is therefore necessary.

Experiments with defibrinated blood and with filtered bile.—Various experiments have been made with defibrinated blood. Nicolle and Bey have published the statement that filtered, defibrinated blood will not kill and will not give rise to any immunity. Kolle, Turner, and Maberly agree with this view and add that the residue on the filter may be virulent.

Rogers, Maberly, and Verney state that the bile, which of itself may cause the disease (Kolle), when passed through porcelain filters is harmless, and Maberly adds that the residue which is left behind will give a temporary immunity although it will not convey rinderpest. Rogers thinks that the filtered bile will immunize, and Kolle believes that the residue may be infectious. Kolle used samples of bile which were collected on the fourth or fifth days of the disease.

Owing to the results of these experiments, it has generally been concluded that the causative agent of rinderpest can not pass through the pores of the finer porcelain filters. If this be true it must be larger than the organism of peripneumonia and should be visible (Joest). Since it does not appear in the filtrate of blood which is sufficiently diluted with salt solution to destroy the red cells, it has been thought by some that it must be an intra-leucocytic organism (Nicolle and Adil-Bey) and therefore, for the latter reason, it would not pass through the filter.

Modes of conveyance and infection.—It has already been mentioned that all the secretions of a sick animal are capable of causing the disease, but it has also been shown by Burdon-Sanderson and Koch, that although the blood is infectious from the time of the rise in temperature, the secretions are not capable of transmitting rinderpest until the first symptoms of the disease, visible upon inspection, can be noted. This fact, taken in connection with the viability of the virus, at least partially indicates the commonest means of infection, as well as the most usual modes of conveyance.

For many years it has been established that the introduction of infected material into the body of susceptible animals, whether into the blood or tissues or upon the mucous membranes, especially those of the nose and mouth, will cause rinderpest and therefore, freshly infected bedding, utensils, and other implements which have been used while caring for cattle may be dangerous and the disease may also be conveyed on the hands, feet, shoes, or clothing of the attendants. The possibility of transmitting the infection by biting insects is also to be considered because the virus exists in the blood. In the case of very susceptible animals, a very minute amount of blood, when introduced beneath the skin or mucous membrane, would convey the disease.

The length of time during which the virus may remain viable in the soil and in stables is not determined. We know that physical conditions promptly affect the life or activity of this virus, but we also know that stables or pastures may remain dangerous for long periods. The cause of the continuance of this infection in such instances is not known. Whether it be that insects are the important factor or whether the virus remains for a long time in an active condition in the soil is also not clear. This is the more curious, inasmuch as it does not show any evidence of maintaining its viability in laboratory media prepared

either from the waste substances of the body or from mixtures of nutrient materials. I experimented unsuccessfully with media composed to resemble the soil in their chemical constituents; neither was I successful in cultivating an organism capable of causing rinderpest in media containing bile, blood, lecithin, cholesterin, nucleo-proteïds, etc.

SYMPTOMS.

The first apparent symptom of the disease is a rapid rise of temperature, after an incubation period of from three to six days. (Chart 4, No. 904.) This rise almost invariably appears between twenty-four to thirty-six hours before any other symptom is apparent. (Chart 8, No. 1.) The next one, at least in animals from the Philippines, is an injection of the conjunctivæ which is immediately followed by a profuse, sero-purulent discharge from the eyes, often so irritating as to produce excoriation in its course across the face. A varying degree of salivation is also observed, but in Manila, ulcers of the mouth or lips are rarely seen. There is a somewhat profuse, fetid discharge from the nose. With the onset of these symptoms, the appetite diminishes and is finally completely lost; rumination ceases and a rapid diminution in weight follows; the coat is staring. The beginning of the diarrhœa varies; it may be either early or late in the disease; in the usual course it becomes muco-sanguinous, whereas the less virulent forms may run their course almost to the end with no more than an ordinary, very fluid diarrhœa. A peculiar odor of the intestinal discharges is almost characteristic of rinderpest. When the disease is virulent, tenesmus becomes marked and as a result, prolapsus of the rectum is of not uncommon occurrence. Death occurs in collapse, following a fall of temperature, it usually takes place between the sixth and eleventh days of the disease. (See cases, Chart 8, No. 1, and Chart 9, No. 3.)

Abortion follows with regularity in the case of pregnant animals and lactation ceases in milch cows.

The natural disease in Philippine native, non-immune cattle either may show a gradually rising temperature, which reaches its maximum on the second or third day; or a rapid rise to a maximum which is persistent, with the exception of the morning fall, until the lethal drop; or again a sudden advance, followed by a fall and a normal subsequent temperature or, indeed, no well-marked rise at all. So far as our observation goes, there has been no case of the natural disease without diarrhœa, which usually occurs between the fourth and sixth days.

The usual experience with the disease which is artificially produced is a well-marked reaction. However, in some instances this has either been very moderate or even scarcely perceptible; in a few there has been a gradual, rising reaction and in but one or two a sudden, moderate

advance followed by as rapid a fall, after which the temperature only varied within normal limits until it showed the quick, lethal depression. In one such case, no diarrhœa occurred, although an autopsy conclusively demonstrated rinderpest to be present.

Our observations in general may be condensed as follows:

(*a*) In native, susceptible animals pastured on infected ground, rinderpest may appear at any time between the fifth and twenty-third days. (Chart 10, No. 839.)

(*b*) After inoculation with virulent blood, the disease appears between the third and fourth days. (Chart 11, No. 932.)

(*c*) Diarrhœa becomes evident between the fourth and sixth days after the onset of the fever. (Chart 11, 932.)

(*d*) The temperature may vary between 39°.4 and 41°.8.

(*e*) Death is preceded by an abrupt fall of temperature and occurs six to nine days after the reaction. (Chart 10, No. 839.)

MORBID ANATOMY.

There is some difference of opinion in regard to the characteristic lesions of this disease. The European, South African, and Philippine types of rinderpest differ in many points; perhaps it is true that none of the morbid changes are constant and that they may vary in different countries, epidemics, and animals (Walley).

The most constant alterations in the body are emaciation, sero purulent conjunctivitis, congestion, and general inflammation or ulceration of the gastro-intestinal tract, the latter changes being especially localized in the fourth stomach and pylorus; however, the mucous membrane of the fourth stomach and of the large and small intestine may simply show a diffuse reddening at the summits of the folds. Petechiæ are encountered not only in the gastro-intestinal epithelium but also in the heart, kidneys, liver, and lymphatic glands. Often, the only demonstrable lesions may be those of the fourth stomach, pylorus, and upper part of the small intestine

In the Philippine Islands, as Jobling has mentioned, we rarely, if ever, encounter the classical cutaneous eruption described in the European disease; it is also true that ulcerations of the nasal and oral mucous membrane are rare, as are those of the patches of Peyer. In place of this condition, a congestion is present in most cases.

The gall bladder is usually distended and contains a thin, greenish bile. The vagina is always congested and the urinary bladder occasionally presents a similar condition.

There are also no discoverable changes in the blood, unless, perhaps, there is a leucopenia of mild degree. In cases in which diarrhœa is severe it is certain that a general concentration exists, and in at least some instances there is not only a relative but also an absolute diminution in the number of white blood cells. The following figures, which

are compiled from the records of Dr. Ruediger, of the Serum Laboratory, serve to illustrate the changes:

Normal cattle:

Average of 27.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{7,050}{6,043,000} = \frac{1}{790}$$

Rinderpest cattle:

Average of 10.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{9,820}{9,112,600} = \frac{1}{927}$$

Average of 3 animals which had no diarrhœa.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{9,500}{7,740,000} = \frac{1}{815}$$

Average of 4 animals with moderate diarrhœa.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{10,300}{8,112,000} = \frac{1}{737}$$

Average of 3 animals with severe diarrhœa.

$$\frac{\text{Leucocytes}}{\text{Red cells}} = \frac{9,400}{11,813,000} = \frac{1}{1,256}$$

According to Refik-Bey the leucocytes vary as follows: There is an initial rise on the second or third day, a later decrease on the fourth to seventh, and a terminal increase on the seventh to ninth; they are at a minimum on the day of the initial advance in temperature. In most instances the mononuclear cells do not increase at this latter time, but do so steadily after the stage of diminution of the leucocytes is passed. In some instances there is a mononuclear leucopenia. The polymorphic leucocytes usually follow the path of the mononuclears.

In the earier stages of the disease the ulcers in the fourth stomach are preceded by minute, red, hæmorrhagic points which resemble those seen in the early stages of intestinal amœbiasis in human beings. At the site of these points, necrosis takes place with coincident thrombosis of the blood vessels supplying the affected area; gradually, this process extends, until finally an ulcer results which has a punched-out appearance with its necrotic base lying upon the muscular layers or even upon deeper tissue; the sides and bases of these ulcers consist in many instances of an almost homogeneous material which is partly granular, staining diffusely and devoid of nuclei. In some places remnants of polymorphonuclear leucocytes are seen. The tissue beyond this zone of necrosis is œdematous and densely infiltrated with polymorphonuclear leucocytes; the blood vessels are congested and the muscular fibers are cloudy and swollen. The mucous membrane at a distance from the

ulcers is injected and thickened. Many bacteria can be found in the sloughs adhering to some of the ulcers. Deeper in the tissues, although stained carefully with both intense and delicate stains, no elements can be discovered which from their relation could be supposed to be causative. Indeed, in most cases there are no foreign elements in the deeper parts of the lesions; I have been able to study but few from the mouth and these show nothing more than a circumscribed, superficial necrosis. Many varieties of micro-organisms could be seen in the covering, coagulated material.

ASSOCIATION WITH OTHER DISEASES.

The association of rinderpest with other diseases has proven itself to be, in many places, most important because excessive losses have occurred as a result of the neglect of the danger arising from the complicity of latent blood diseases such as Texas fever and trypanosomiasis. We have had to deal with both of these conditions in the Philippines. Jobling and I [2] have given an account of our experiences with American cattle which were purchased above the Texas-fever belt in the United States, in order not to introduce that disease into these Islands. These animals were given two preliminary prophylactic doses of antirinderpestic serum, which were then followed by an injection of virulent blood twelve days after the second inoculation. At that time we were not aware that Texas fever was endemic in the Islands and so, unwittingly, through the virulent blood infected the American cattle with the latter disease. The result was disastrous, for the combined Texas fever and rinderpest killed some of the animals. Since then we have had several cases in Philippine and Shanghai cattle in which, during an attack of rinderpest, flaring up of a latent Texas fever has occurred. (Chart 12, No. 512.) The combination has resulted in the death of the animals.

We have had no difficulty with trypanosomiasis, chiefly for the reason that we have always been aware of its presence and been prepared for it. For a long time, we have made systematic examinations for the parasite in all animals from which blood was to be taken for inoculation and occasionally we examine every member of the herd. Trypanosomiasis is widespread among the cattle in the Islands, but is most common in the carabaos, which, strangely enough, do not generally suffer any great inconvenience from the infection, provided they are not herded together, have good food, and are kept at work under normal conditions.

Lately, in the Island of Negros, the experience of the veterinary corps with simultaneous inoculation against rinderpest in a district where trypanosomiasis was subsequently found to exist, was most instructive. In 1904 Dr. Jobling had learned that the carabaos may harbor

[2] *Publications, Serum Laboratory, Bureau of Government Laboratories* (1904), 14.

trypanosomata with no bad effects in a large majority of cases, but the problem of the evil effects of the combination of these parasites with rinderpest had never been encountered until toward the end of 1905, when a campaign by the Bureau of Agriculture was instituted to inoculate by the simultaneous method all the cattle on the island mentioned above. At the beginning of this work the results were very satisfactory, but at a later period when the corps had advanced into territory in the north of Negros the death rate rose to an alarming extent and investigation showed the bad results to be due to the inoculation of trypanosomata which were present in the virulent blood. When serum alone was used, or in cases in which there was no reaction to the simultaneous inoculation, the cattle were not affected, but if a reaction occurred the animals died without symptoms of rinderpest, but with enormous numbers of the parasites in the blood.

In Egypt, similar unfortunate results following the simultaneous method of inoculation were observed, but in this case the complicating diseases were Texas and Rhodesian fevers (Arloing).

The most common complicating condition beside these parasitic blood diseases is foot-and-mouth disease, which, although milder in Manila than in the temperate climates, is nevertheless a very serious infection when it occurs in conjunction with rinderpest. Ordinarily, simple foot-and-mouth disease in native or Chinese cattle yields readily to treatment in Manila, but when it appears in conjunction with rinderpest, the combination is almost surely fatal and serum then has no effect upon the course of the malady.

PROPHYLAXIS.

That there are in general but two methods of preventing the entrance and spread of rinderpest, whether in a herd or a country, has now been settled beyond doubt. These methods are those of immunization and of quarantine. Naturally enough, were a perfect quarantine to be established about a herd or about a country where the disease is unknown, then the method of prophylaxis by immunization would be unnecessary. However, unfortunately this is so rarely the case, that resort must be had to the latter means of protection.

Methods of preparing serum.—In order to prepare a serum of high efficiency it is at first necessary to produce in an animal an active immunity against the disease. Various investigators have attempted to accomplish this result by using attenuated virus, but with little success. Heat and cold, light and air, and antiseptics have been tried by Nencki, Semmer, Tokishiga, and others, but, as Koch has said, the susceptibility of the virus does not allow of even gradual attenuation. The result of such chemical and physical methods is therefore to destroy the virus and then all evidence of an immunizing process is wanting.

Gerlach attempted to make use of sheep and goats for reducing the virulence, but these experiments did not result in any true attenuation, for at a later date Koch, and Kolle and Turner showed that in the case of goats the lessening of virulence which might occur was of so incomplete a degree that no practical result was accomplished, while with sheep the virulence was, if anything, increased.

If one can not obtain a naturally salted animal with which to commence operations, it is necessary so to produce the disease in one that it will recover spontaneously and therefore become artificially immune.

Koch, in the course of his investigations in South Africa, discovered that he could accomplish this result by the injection of fresh bile, taken from an animal sick with rinderpest, into a well one. Later, he found that the blood of salted cattle would in some degree protect and that it might be used in combination with virulent blood with good results. Having recourse to these two methods, it was simply necessary to take a salted animal and by the injection of more virulent material gradually produce such a degree of immunity that the serum would be efficient in small doses. Theiler and Pitchford, Danysz and Bordet, Kolle and Turner, Nicolle and Adil-Bey, and others applied these methods with most excellent results. Kolle and Turner used gradually increasing amounts of virulent blood, injected at certain intervals beneath the skin of the cattle. Nicolle and Adil-Bey used the more rapid method of injecting 4 to 8 liters of virulent blood with 25 cubic centimeters of serum.

Still another method, introduced by Yersin, is that of peritoneal lavage, but this has not been extensively employed.

The method in use at the Serum Laboratory of the Bureau of Science.—In our work, the animals to be used for the production of antirinderpestic serum are first inoculated with this serum in amounts varying from 50 to 100 cubic centimeters. After an interval of a day or two, or sometimes perhaps after seven to ten days, they receive from 1 to 10 cubic centimeters of virulent blood; after this injection, others are given two weeks apart and in the following amounts: 50, 100, 250, 500, and 1,000 cubic centimeters. The last injection having been given, three bleedings follow at each of which from 3,000 to 3,500 cubic centimeters of blood are drawn, and when this has been accomplished, 1,500 cubic centimeters of virulent blood are once more injected. Ten days thereafter three additional bleedings are made and again virulent blood is used in a dose of 2,000 cubic centimeters to be followed, as in the other cases, by three bleedings. The same procedure obtains with the subsequent injections of 2,500, 3,000, and 3,500 cubic centimeters of virulent blood. A reaction, to be recognized by a rise in temperature, should result after each injection of virulent blood.

Methods of producing immunity.—Generally speaking, there are three methods of securing an immunity to rinderpest, namely, the active, the passive, and the combined active and passive (Sobernheim). The active immunity is ordinarily of longer duration than the passive and in

animals which have recovered from the natural disease, it is apparently permanent.

The methods in use for producing active immunity are also three in number.

I. *Koch's bile method.* According to the results of Koch's experiments in South Africa, 10 cubic centimeters of bile taken from an animal on the sixth to the eighth day of the disease will, upon injection into a non-immune one, confer an immunity which will persist for several months. The bile to be used must be clean, greenish and frothy, and must be unmixed with blood; however, in following this method the immunity is not demonstrable until about the tenth day after the inoculation. Rogers, in order to render any bile from a rinderpest animal available, has advocated its filtration, which would remove all organisms contained in the fluid; however, Kolle and Turner have demonstrated that this method could not be satisfactory, because, in order to produce an active immunity, the organisms of rinderpest should be present in the filtrate. The bile method is said to produce an active immunity (Kolle), and it is maintained that the organisms present therein are virulent, but that they are accompanied by substances which hinder their spread in the animal inoculated. The same results can not be obtained with virulent blood and normal bile. Not all investigators have had as favorable results as Koch; those of Lingard and Rogers, for instance, were negative, but this was possibly due to racial differences in the cattle. Inoculation with bile has no value as a curative method.

The advantages of this method are that no reactionary fever, suppression of lactation, or abortions are produced and that the operations can be carried on in the field. The disadvantages are that immunity is not established until the tenth day after inoculation, that the latter is not permanent (four months, Haedicke), that a sufficient quantity of bile may not be obtainable and that it is difficult to preserve, although perhaps the observations of Nicolle and Adil-Bey, that bile desiccated in the presence of sulphuric acid will keep indefinitely, may be confirmed.

II. Hohlstock's modification of Koch's method which consists in giving the bile inoculation a second time and then injecting virulent blood from ten to thirty days thereafter has not found much favor, since Kolle and Turner have shown that there was no appreciable increase in the immunity conferred by this method.

III. Edington's Glycerinated Bile Method, although it has found favor in some places, has been condemned by Kolle and Turner on the ground that the glycerine destroys the virus, and Hutcheon and Rogers state that only a short passive immunity is conferred.

Edington's procedure was to take clean bile after the sixth day of the disease, and dilute it with an equal amount of glycerine; it should then be set aside for eight days. Edington used 15 to 50 cubic centimeters injected into the dewlap, and followed this by a small amount of virulent blood (0.1 to 0.2 cubic centimeter) two days thereafter (ten days later, Nocard and Leclainche). Rogers thought that even foul bile might be used, since glycerine would destroy the organisms present therein.

The advantages claimed for Edington's method were that a long immunity was conferred on all animals which had a reaction and a

temporary one in the case of nearly all the others, and that the bile could be kept for a year (Edington), eighty-five days (Nicolle and Bey), one hundred and sixty-two days (Rogers). The immunity lasts for from two weeks to six months (Jobling).

The disadvantages were that no immunity appeared before the eighteenth day, that many animals did not react and that therefore they would contract the disease from the blood inoculation and die, that two inoculations were needed, and that it was necessary to bleed a sick animal to obtain virulent blood.

COMBINED METHODS OF IMMUNIZATION.

1. *Serum simultaneous method* This depends upon the fact that when 1 cubic centimeter of virulent rinderpest blood is inoculated under the skin of one side of the body and a minimal efficient dose of immune serum is injected upon the other, the animal so treated experiences a very mild form of the disease and recovers. (Chart 13, No. 921.) In 90 per cent of the animals a lasting immunity is produced, while upon the 10 per cent in which no reaction occurs, a transient immunity is conferred (Kolle and Turner, Refik-Bey, Nicolle and Adil-Bey).

The advantages of this method are the immediate, permanent immunity produced in the majority of instances, and the transient one in the others, more reactions are produced than with the bile method and only one inoculation is necessary.

The disadvantages are found in the losses by death, which vary from 1 to 4 per cent (among 9,077 cases in Cape Colony there was a mortality of 1.4 per cent), in only temporary immunity in a certain proportion of the animals inoculated, in the interference with lactation and pregnancy, in the difficulty sometimes experienced in obtaining virulent blood,[3] and in the danger of latent blood diseases (Texas fever, trypanosomiasis, foot-and-mouth disease).

This form of inoculation has been variously modified. Nencki and his co-workers, Sieber and Wysnikowitsch, advise giving the serum two hours and Hutcheon administering it forty-eight hours after the virulent blood, and then to watch the temperature and once more to administer serum.

2. *Deferred virulent blood method.*—Another modification and one which is generally used in our work, is to give the serum a day or several days before the virulent blood. (See Chart 14, No. 106.) In using this modification we also follow Roger's suggestion of carefully watching the temperature of the animals, and, if no reaction occurs after the inoculation, a second inoculation with 10 cubic centimeters (2 cubic centimeters for calves) of virulent blood is made. This method requires

[3] To obviate this last difficulty it has been advised to use sheep to propagate the infection, etc.

more labor than the other, but the mortality is less and more reactions are obtained than by any other.[4]

It is necessary to standardize any serum for the race of cattle on which it is to be used for the purposes of inoculation and to this end a number of cattle should be inoculated each with 1 cubic centimeter of virulent blood and with 10, 20, 30, and 40 cubic centimeters of serum. The efficient dose is the one which allows a febrile reaction to take place but after the administration of which the animal shows no other symptom of the disease. In certain cases 20 cubic centimeters will accomplish this result, at least this is as a rule the minimal efficient dose of serum for the race of cattle with which we have to deal in the Philippine Islands; however, even here it will be found that this amount will vary with the racial susceptibility and in a number of instances must be much increased.

Passive immunity by the use of serum.—The method for obtaining passive immunization has been indicated in the section on preparation of serum; its origin lay in the observation that the serum obtained from naturally salted cattle possessed a slight immunizing power and that by the use of large doses, a temporary immunity could be established which would protect otherwise non-immune animals against the natural or inoculated disease.

Several workers, in continuing the study of the natural process, by injecting successively increasing amounts of virulent blood into salted animals, were able to produce a very efficient serum which could be used successfully in doses of 10 to 20 cubic centimeters (Kolle and Turner). Such a serum is also stated to possess curative power.

The immunity resulting by the use of serum alone is transient; according to various observers it varies from several weeks to a number of months, depending upon the quantity employed which has been injected into the animal; 100 to 200 cubic centimeters may produce an immunity which will last through the more extended period.

The advantages of the serum method are that there is no reaction, that no unfortunate results follow in dairy or pregnant cattle, that it

[4] In our work repeated injections of large amounts of antirinderpestic serum in certain races of cattle before active immunization with virulent blood and serum have not given favorable results. These repeated large doses of serum were employed in a number of American cattle in which it was considered advisable to produce a passive immunity at a time when, owing to a long voyage or for other reasons, they were not considered in a sufficiently good general physical condition for active immunization. Many of these animals (which were inoculated with repeated does of serum) and with virulent blood some days after the injection of the first large dose of serum, succumbed to a severe infection of rinderpest or of rinderpest in combination with Texas fever.

Apparently, the repeated doses of serum produced antibodies in the animal body.—P. C. F.

will favorably modify a disease of one to three days' duration, and that the serum probably keeps well for long periods of time.[5]

Dschunknosky and Kupzis experimented on a process of desiccating serum, which they stated was satisfactory. We followed the method advised by these writers and obtained a product which, while it was apparently useful, was soluble with such difficulty that it was valueless for rapid work in the field. Since the serum if kept in a cool place, retains its activity for a sufficient time, we have adhered to the old method of bottling it in liquid form.

Method of immunizing by defibrinated blood.—In addition to the simultaneous method and its modifications, other systems have been in vogue in certain localities. The best known of these consists in the use of defibrinated, virulent blood, introduced by Danysz and Bordet.

The dosage varies from 50 to 200 cubic centimeters. Immunity is immediate, there is no reaction, and the whole process can be carried out in the field. However, the immunity is but temporary and the material must be perfectly fresh and free from pyroplasmata, trypanosomata, etc. Danysz and Bordet in following this procedure subsequently exposed the animals to infection. Sobernheim maintains that the method is not reliable, but Hutcheon has had success with it; however, Theiler could immunize but 30 to 40 per cent of the exposed animals by this method. A great disadvantage lies in rapid deterioration of the product.

THE COMPARATIVE VALUE OF THE METHODS OF IMMUNIZATION FROM AN EPIDEMIOLOGICAL POINT OF VIEW.

Although rinderpest has great interest as a scientific study, it has in all probability claimed so much attention among investigators because of its economic importance. It is this side which naturally appeals most strongly to the cattle owners, especially in countries or districts where it is difficult to explain just what the meaning of immunization is. It is very difficult for the lay mind and especially for semi-educated people to comprehend that it is not only for the present but also for the future as well that we must work. They insist that we simply tide over existing epidemics, instead of combining such methods of work as will prevent future ones.

The problem resolves itself into the treatment of clean and infected herds in countries where the disease is endemic and in those in which it is merely sporadic and dependent upon introduction from the outside.

In the latter case, even if the serum or bile method alone is used and this means is supplemented by a strict quarantine against outside animals, the spread of the disease can certainly be completely checked.

Greater difficulty undoubtedly arises in countries where the disease is endemic, where new epizoötics are constantly cropping out and where the outbreaks are not apparently due to outside influences. Under such

[5] Theiler and Bitter state the period to be four years.

conditions not only must the disease be checked but active immunity must be conferred on as many of the cattle present in the district as is possible. In order to accomplish this result with a minimal loss of life it is necessary to draw a careful distinction between infected and noninfected animals. In our work, we have divided the cattle with which we have dealt into a "noninfected" and a "contact" class. The latter have been treated with serum, to protect them if noninfected and to favorably influence the course of the disease if they are infected. Later, when it has been possible, these have been given virulent blood in order permanently to protect them. This final inoculation has chiefly depended on the owner's consent. In the case of clean herds, we have thought it wise to use the simultaneous method of Kolle and Turner, giving serum and blood at the same time, or following the serum by the blood, as is done with the animals at the laboratory. Up to the present, the valuable suggestion of Rogers, which involves the regular taking of temperatures of all animals inoculated, has been insisted upon, in order that the records of the animals might be complete and also in order that the reaction necessary in the establishment of immunity should, if present, be noted. In the absence of this reaction we advise a second injection of virulent blood.

During the early days of the rinderpest work in these Islands, much of the work of inoculating was done at the laboratory corral. Persons would bring their animals to this place and leave them until they were ready to be returned. Owing to inexperience a mistake was made at that time in not delaying the inoculation until the animals had been under observation long enough to be sure they were not already infected with rinderpest. During the first eight months, 163 cattle and carabaos were inoculated at the laboratory: 114 received simultaneous inoculation and of these 28 died, a death rate of 32.55 per cent. These results were explained by the fact that most of the cattle sent to the laboratory for treatment had been shipped on infected boats and that probably they were in the incipient stage of the disease when inoculated. Some of the animals also came from districts in Borneo where rinderpest had never been encountered, and these, possibly, were abnormally susceptible to the disease.

During the same time, 28 animals received serum alone and of these four died, a death rate of 14.28 per cent; 11 were given symptomatic treatment only and of these 6 succumbed, a death rate of 54.54 per cent. Such results show that, even in possibly infected animals, serum may be of value, although in this instance the number of infected animals was not known.

There was a mortality of 13.15 per cent from simultaneous inoculation in calves; 15.8 per cent among those to which serum alone was given, and 100 per cent with the individuals which received symptomatic

treatment only. Here again, as in the case of the cattle, the deaths after serum treatment were higher than we might have wished, because some of the animals were in the incubation period of the disease when inoculated, but at the same time, the mortality was not so great as it might have been had serum not been used, which is taken as an evidence of its curative power. This subject will be dealt with below.

During the same period, from January 1 to August 31, 1903, 1,491 animals in the provinces received simultaneous inoculation; 42 of these died, a death rate of 2.8 per cent. Of 776 which were given serum inoculation, 48 died, a death rate of 6.1 per cent. Here again, the curative value of the serum must be taken into consideration in explaining the percentage of loss among animals receiving serum only, for undoubtedly many more were infected with rinderpest than succumbed to the disease.

During the succeeding year the task of inoculating in the provinces was transferred to the veterinary corps of the Board of Health, so that the records of the laboratory cover but part of the period included between September 1, 1903, to August 31, 1904.

These records show that between September 1, 1903, to June 15, 1904, 3,117 provincial inoculations were undertaken by the simultaneous method, with a mortality of 4.09 per cent; 4,461 with serum alone, with a mortality of 0.11 per cent, or a total mortality for both classes of 1.76 per cent.

During the months from April to August, 1903, there were 1,402 animals inoculated with serum or with blood and serum on the Island of Tablas. The records of 1,128 cases are complete and show that of 507 inoculated by the simultaneous method but 6 died, a mortality of 1.18 per cent, and of 621 to which serum alone was given 35 died, or 5.63 per cent. Here again, as in the previous instances, there is some evidence of the curative value of serum.

The results of an attempt to immunize American cattle which were shipped to the Islands for dairy purposes were disastrous, probably because of their extreme susceptibility. (See Chart 15, No. 10, and Chart 16, No. 2.) Upon their arrival in the Philippines all of them received 200 cubic centimeters of a serum, 30 cubic centimeters of which would protect native or Chinese cattle against the inoculated disease. About twelve days later, some of these American animals received the simultaneous inoculation—i. e., 30 cubic centimeters of serum and 1 cubic centimeter of virulent blood. In any case, whether they received virulent blood, or simply serum, all but a few sickened and died of rinderpest and this in spite of early and late subcutaneous and intravenous injections of serum. Indeed, one animal beside the original dose of 200 received 730 cubic centimeters of serum (in all

930) with only this difference, that she lived two days longer than the others.[a]

Undoubtedly, in some cases death was due to a combination of Texas fever and rinderpest, but such instances were few. No difficulty was experienced with the calves belonging to the same herd. To be sure, the dosage of 30 cubic centimeters of serum was used, but they resisted the disease and were later given simultaneous inoculation with good results.

Littlewood, after an interesting experience in Egypt, says it is possible that serum, when injected into imported animals, does not afford the same protection against rinderpest as it does in native herds, more especially if these animals have been exposed to adverse conditions.

I believe that by a judicious use of the serum and simultaneous methods, epidemics may be controlled and the cattle in a district immunized. In the absence of serum, glycerinated bile or defibrinated immune blood may be used as Hutcheon advises. He states that every animal showing a rise of temperature should receive 100 cubic centimeters of serum, a procedure which is practiced in the Philippines. For an animal which has recovered from the natural disease, he advocates the inoculation of 30 cubic centimeters of glycerinated bile, or 300 to 400 cubic centimeters of defibrinated blood. He also advises, as do we, that all infected animals should receive intravenous injections of serum. He argues against the use of fresh bile in infected herds, and believes that this procedure should be applied only in the cases of noninfected animals.

Sobernheim and Haedicke believe that the two most valuable means of combating rinderpest are the bile method of Koch and the simultaneous one of Kolle and Turner. The former is most applicable at the outset of an epidemic, in a country where serum is not available, and the latter should be used extensively in a land where the disease is endemic.

When it is necessary to immunize dairy cattle or pregnant animals the serum method is very valuable for temporary protection. Later, the simultaneous method can be employed. It is also possible, by carefully regulating the dose of serum, to follow it with very small amounts of virulent blood without disturbing the processes of lactation or pregnancy.

Finally, it must be borne in mind that in countries where certain blood diseases are prevalent, it may be dangerous or impracticable to use the simultaneous method.

[a] In all, 56 animals were in the herd which we attempted to immunize; of these 34 were given virulent blood to produce active immunity, and 22 were given serum only, but of the former class, 32 died and of the latter 20. All of the latter contracted rinderpest at about the same time or a few days after the animals which received virulent blood, evidently because the infection spread in the stable. The cattle were received on September 3, 1904, were given 200 cubic centimeters of serum on September 9, and received simultaneous inoculation on September 15.

DIAGNOSIS.

The diagnosis of rinderpest in typical cases presents no difficulty. It may be that in the early stages of an epidemic, the sudden rise of temperature, the serous flow from the eyes and nose, the excoriation caused by the tears, the congestion of the visible mucous membranes, and the severe dysentery may not furnish a sufficiently satisfactory picture upon which to base a diagnosis and that a post-mortem examination will be necessary to decide the matter. The lesions are generally characteristic.

Difficulty arises in those cases in which the temperature reaction is slight and very transient and in which the diarrhœa is late in appearing and is not severe. In such instances an autopsy is necessary.

PROGNOSIS.

The prognosis in uncomplicated cases is bad, in complicated ones even worse. If serum can be used in the early stages of the infection, within twenty-four hours of the first rise of temperature, the chances of recovery are good in all but very susceptible animals. The later in the disease the serum is used, the graver is the prognosis.

TREATMENT.

The serum method is the only one known which is useful in treating rinderpest, but in order that it may have every chance for success, it must be applied before the third day of the disease. The dose should be 100 cubic centimeters injected subcutaneously or intravenously, preferably the latter. The later the stage of the infection, the more necessary it becomes to use the intravenous method It is possible that several injections may be necessary. (See Chart 17, No. 538, to Chart 18, No. 555.)

Hutcheon says, and we agree with him, that no doubt exists of the strong curative properties of fortified serum when it is used in the early stages of the disease, furthermore, the experience of all workers with serum is that a single large dose is much more effective than a repetition of small or even medium ones and that the intravenous injection in sick animals is more effective than the subcutaneous method.

Dr. Sorrel, formerly of the Serum Laboratory, in his experiments to determine the curative value of our serum, has used as much as 500 cubic centimeters for one animal In all the cases upon which the serum was tested, the disease had passed its incipiency; the animals had high temperatures, injected conjunctivæ, profuse discharge from the eyes, and in some instances diarrhœa. Sixteen, in all of which the intravenous method of injection was used, were treated, and of this number 3 died. Three animals received 150 cubic centimeters; six were given 200; five, 300; and two, 500 cubic centimeters. Piroplasmata

were found in the blood and organs of all the fatal cases so that it is possible that death was the result of a combination of rinderpest and Texas fever and was not due to the former disease alone. These records seem to show the curative value of serum, even in the advanced stages of the disease; however, all the treatments were by the intravenous method. If the serum is to be used beneath the skin, then the injection must be given as early as possible. Kolle and Turner, Verney, Maberly, and others, have also spoken of the curative value of serum.

A LIST OF THE MOST IMPORTANT ARTICLES ON THE SUBJECT OF RINDERPEST.

Gamgee: *The Cattle Plague* (1866), London.

Dieckerhoff: *Geschichte der Rinderpest* (1890), Berlin.

Kolle and Turner: *Zeitsch. fur Hygiene* (1898), XXIX, 309.

Koch: *Reiseberichte* (1898), Berlin.

Kolle: *Ergebnisse d. Allg. Pathologie*, Lubarsch u. Ostertag (1899), VI, 470.

Rogers: *Zeitsch. fur Hygiene* (1900), XXXV, 59.

Hutcheon: *Journ. Comp. Path.* (1902), XV, 300.

Dieckerhoff: *Lehrbuch der Specielle Pathologie und Therapie fur Tierärzte* (1903), II, Berlin.

Nocard et Leclainche: *Les Maladies microbiennes des Animaux* (1903), Paris, I.

Jobling: *Publications of the Serum Laboratory*, No IV. *Bureau of Government Laboratories* (1903), Manila.

Plehn: *Der Staatliche Schutz gegen Viehseuchen*, Berlin (1903).

Sobernheim: *Handbuch d. Path. Organismen*, Kolle u. Wassermann (1904), IV, 1246.

Arloing: *Journ. Méd. Vétér. et Zoötech.* (1905), LVII, 321.

Haedicke: *Berl. Tier. Woch.* (1904), L.

Littlewood: *Journ. Comp. Path. and Ther.* (1905), XVIII, 312.

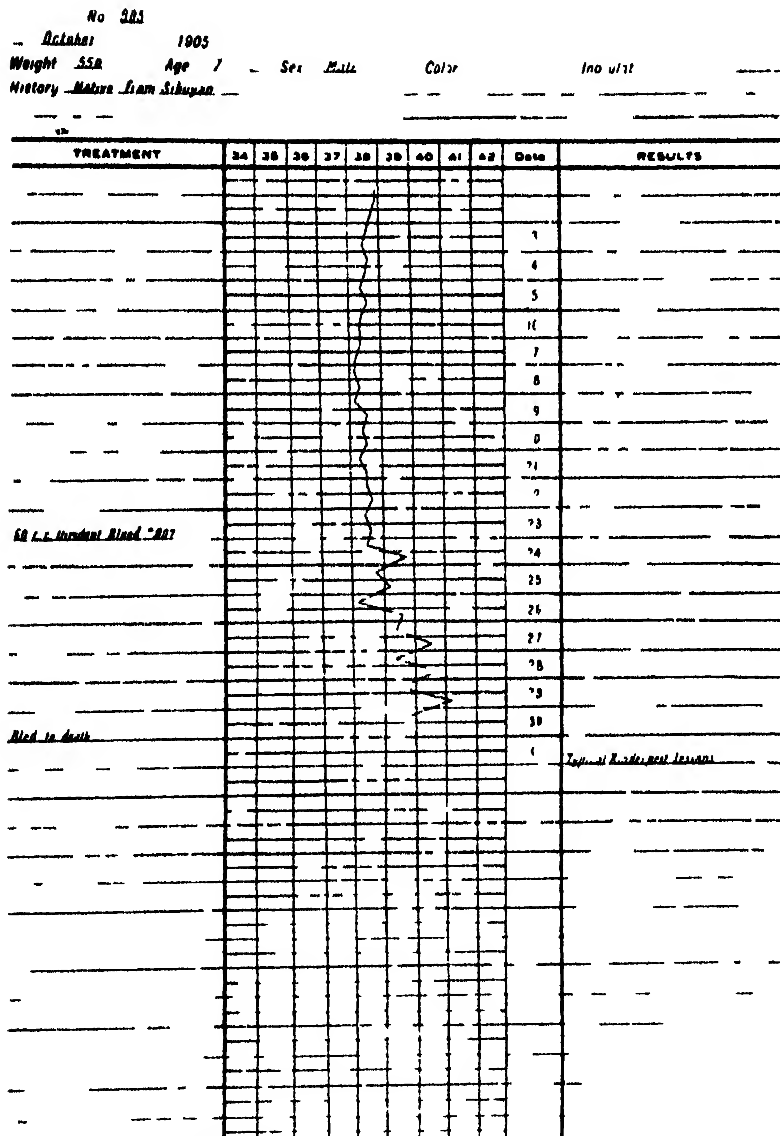

No. 305
October 1905
Weight 550 Age 7 Sex Male Color Inoculat
History Native from Sibuyan
TREATMENT
34 35 36 37 38 39 40 41 42
Date
RESULTS
60 c. c. virulent Blood
Bled to death
Typical Rinderpest lesions

CHART No. 1.

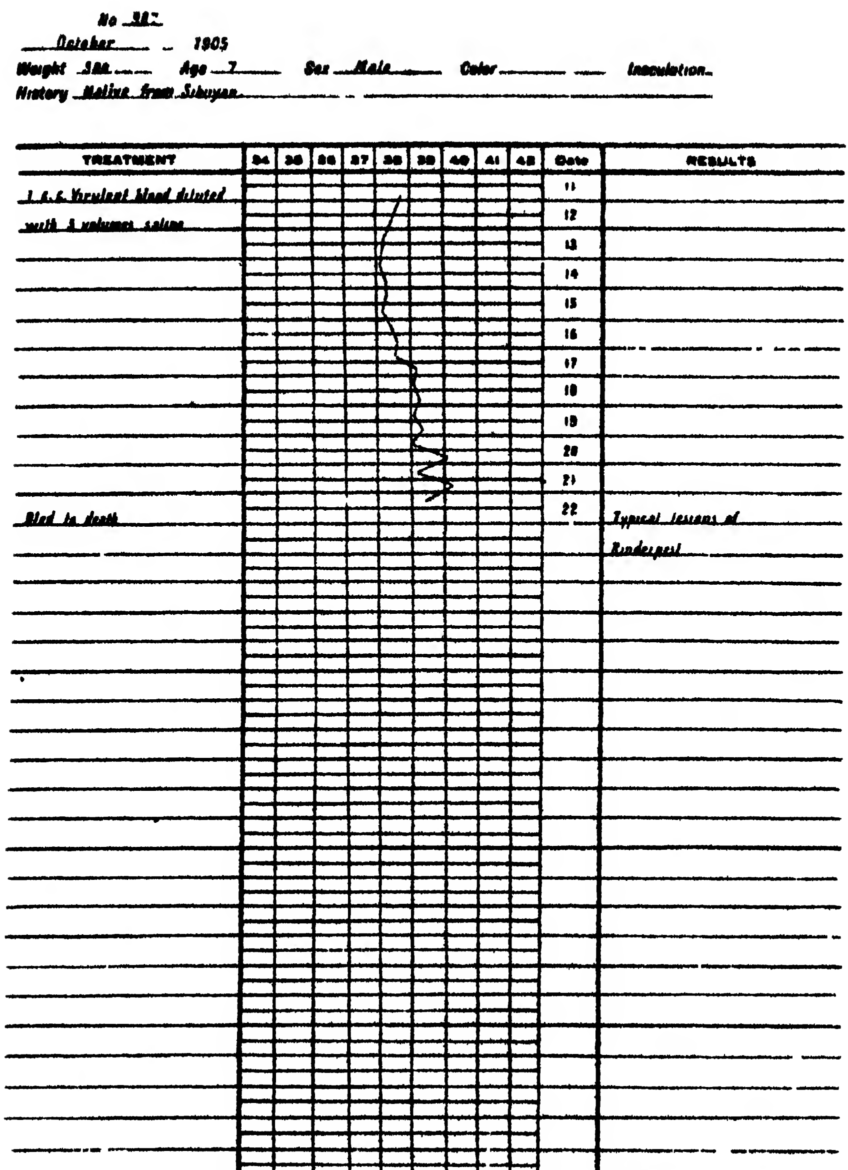

No
October 1905
Weight
Age 7
Sex Male
Color
Inoculation
History Native from Sibuyan
TREATMENT
34
35
36
37
38
39
40
41
42
Date
RESULTS
1 c.c. Virulent blood diluted with 3 volumes saline
11
12
13
14
15
16
17
18
19
20
21
22
Bled to death
Typical lesions of Rinderpest

CHART NO. 2.

No. 988

October 1905

Weight 500" Age 3 Sex Male Color Inoculation

History Native from Sibuyan.

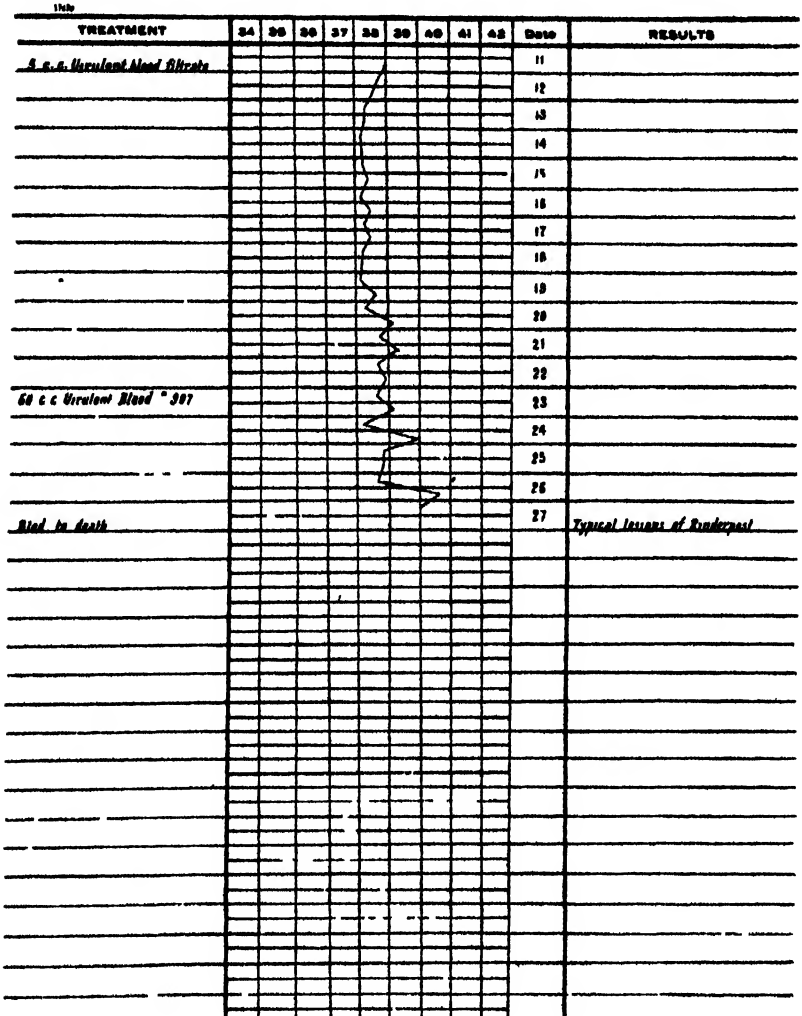


CHART NO. 3

No. 984

October, 1905

Weight 500* Age 5 Sex Male Color Inoculation

History Native from Sibuyan

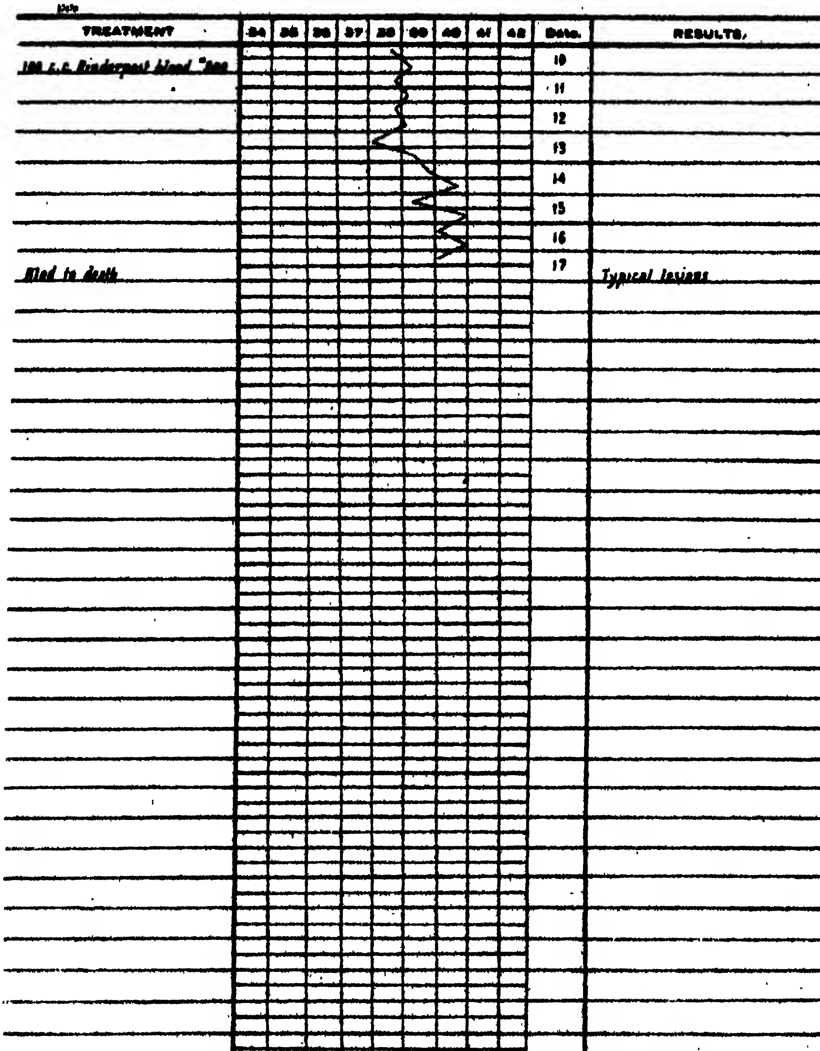


CHART No. 4.

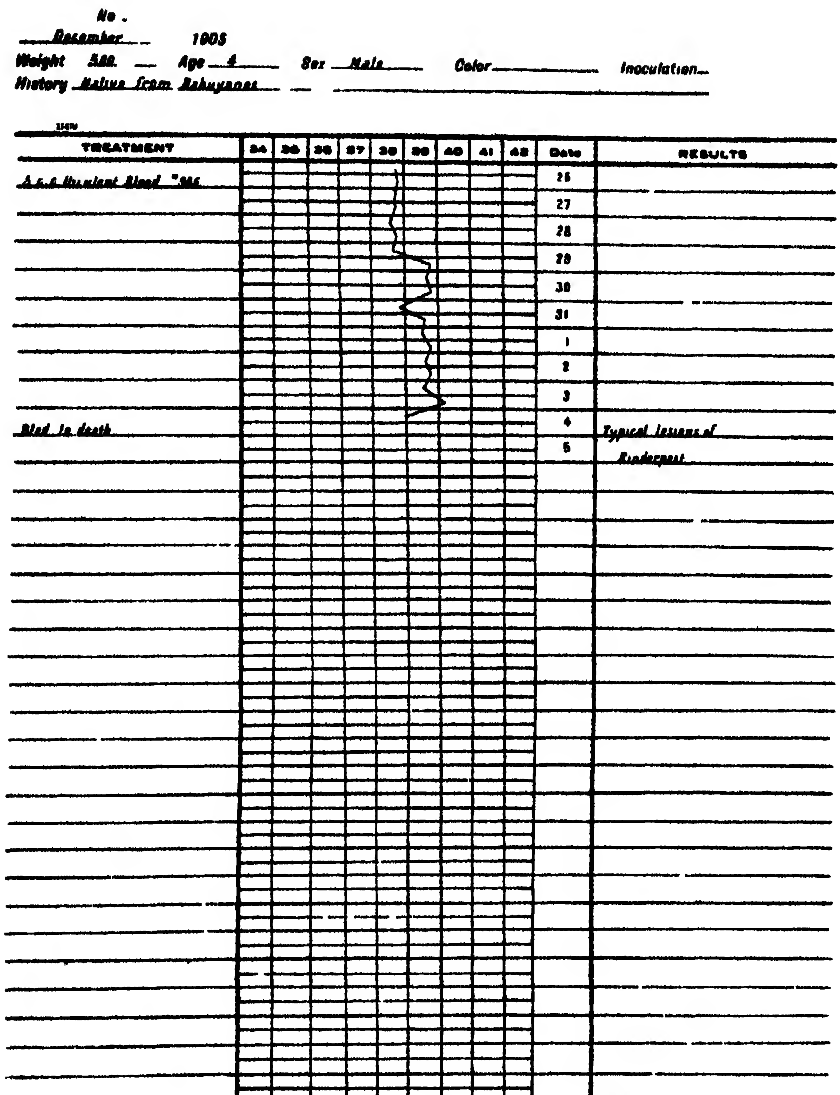

No.
December 1905
Weight 500 Age 4 Sex Male Color Inoculation
History Native from Babuyanes
TREATMENT
34 35 36 37 38 39 40 41 42
Date
RESULTS
5 c.c. Virulent Blood
26
27
28
29
30
31
1
2
3
4
5
Bled to death
Typical lesions of Rinderpest

CHART NO. 5

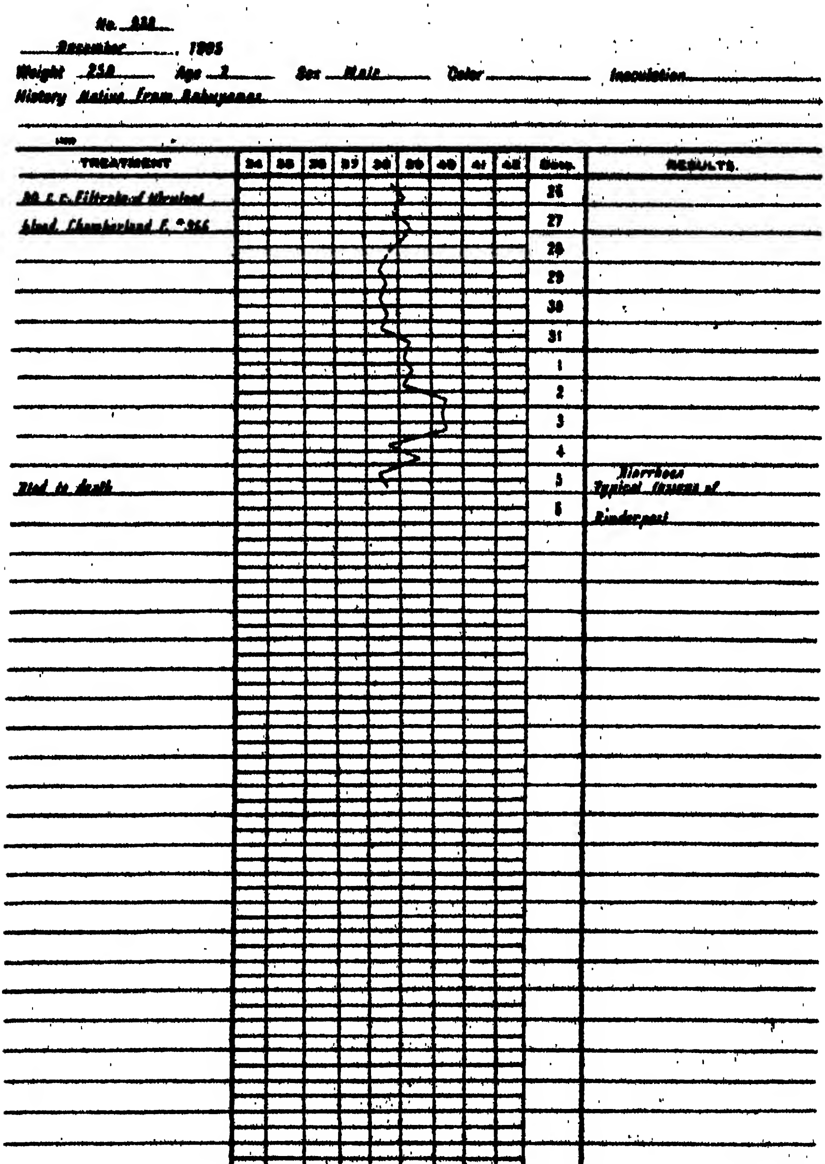

December, 1905
Weight
Age
Sex Male
Color
Inoculation
History Native
TREATMENT
RESULTS.
Bled to death
Diarrhoea
Typical lesions of
Rinderpest

CHART No. 6.

No. 337

December 1905

Weight 400 Age 5 Sex Male Color Inoculation

History Native from Babuyanes

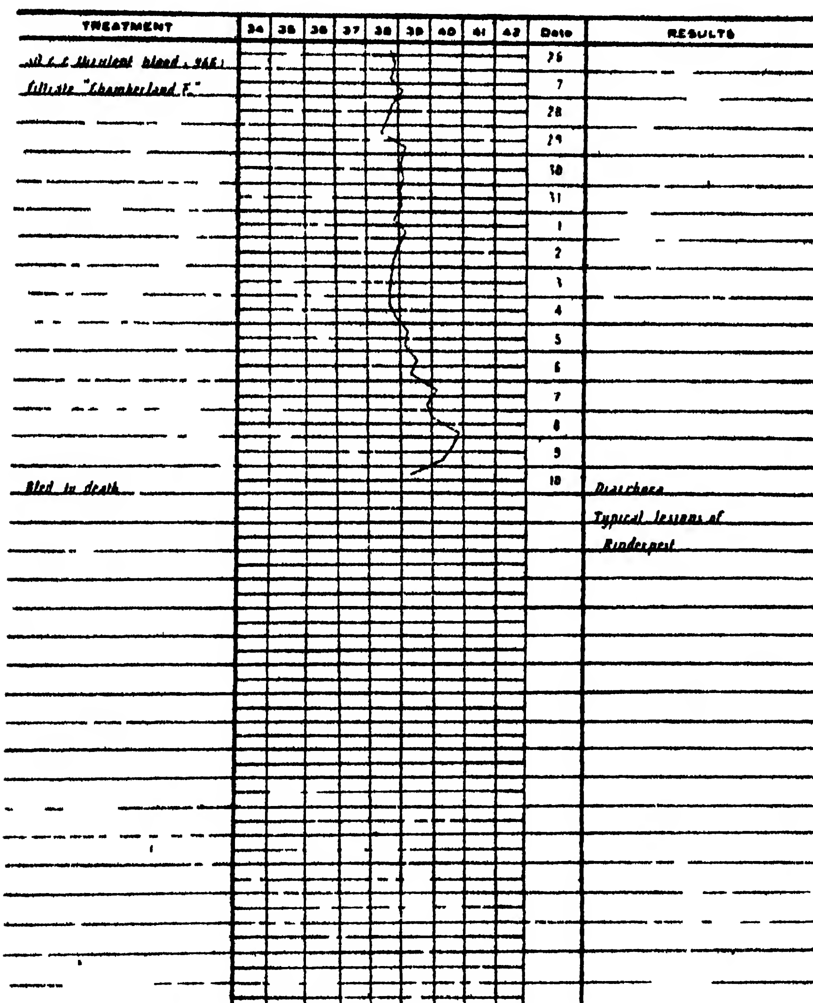


CHART No. 7

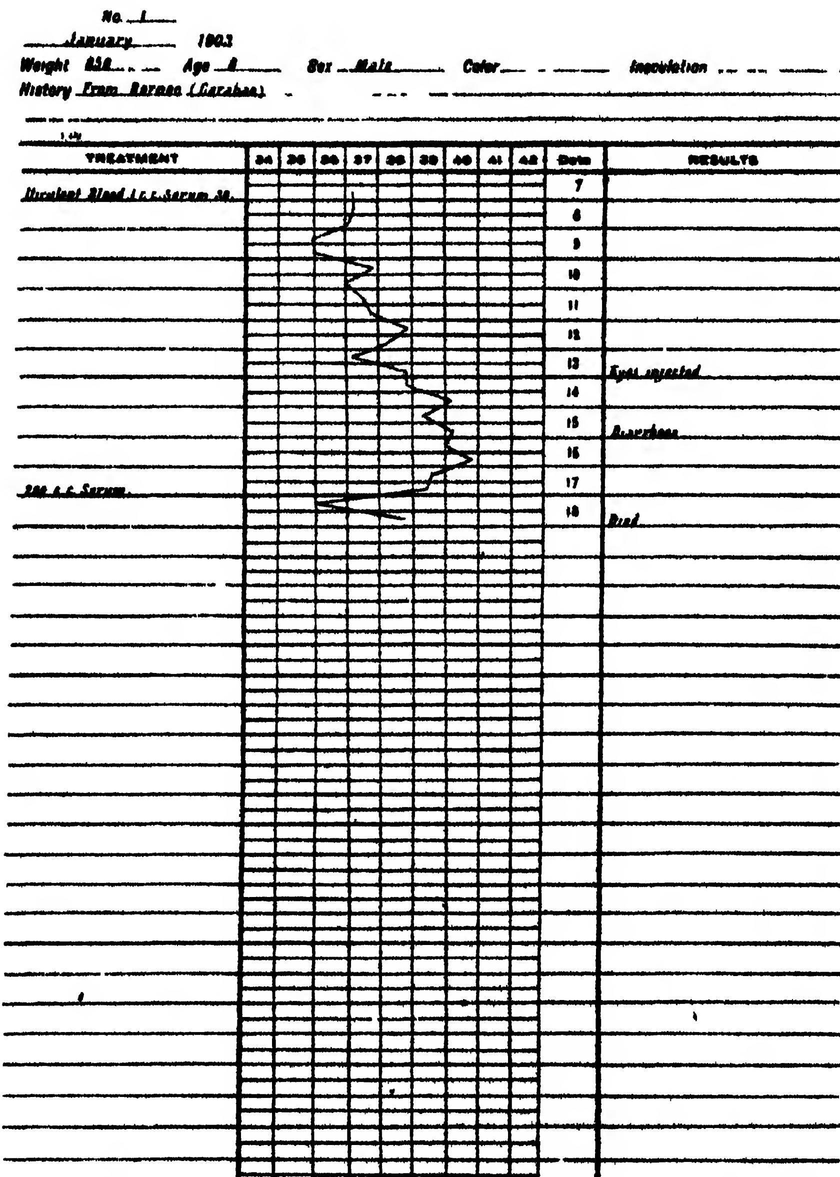

No. 1
January 1903
Weight
Age
Sex Male
Color
Inoculation
History
TREATMENT
RESULTS
Date
7
8
9
10
11
12
13
14
15
16
17
18
Diarrhoea
Died

CHART NO. 8.

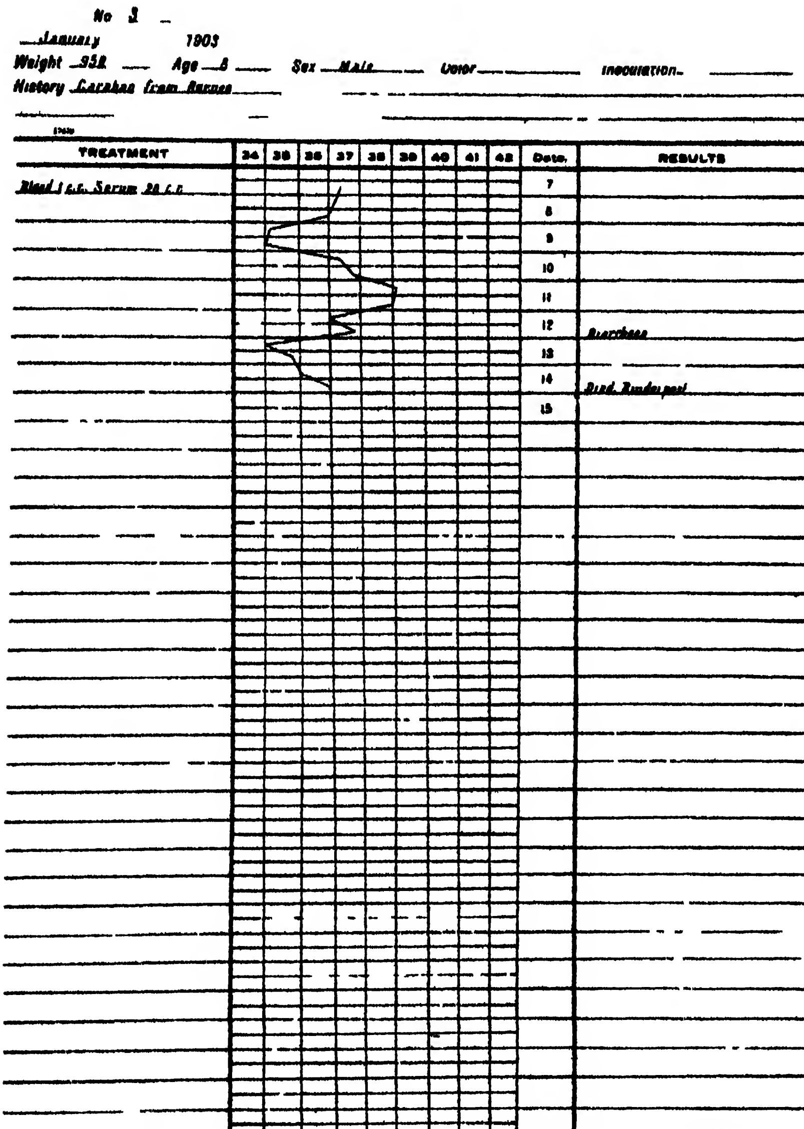

No 3
January 1903
Weight 358 Age 8 Sex Male Color Inoculation
History Carabao from Barnes
TREATMENT
Blood 1 c.c. Serum 20 c.c.
34 35 36 37 38 39 40 41 42
Date.
7
8
9
10
11
12
13
14
15
RESULTS
Diarrhoea
Died. Rinderpest

CHART NO. 9

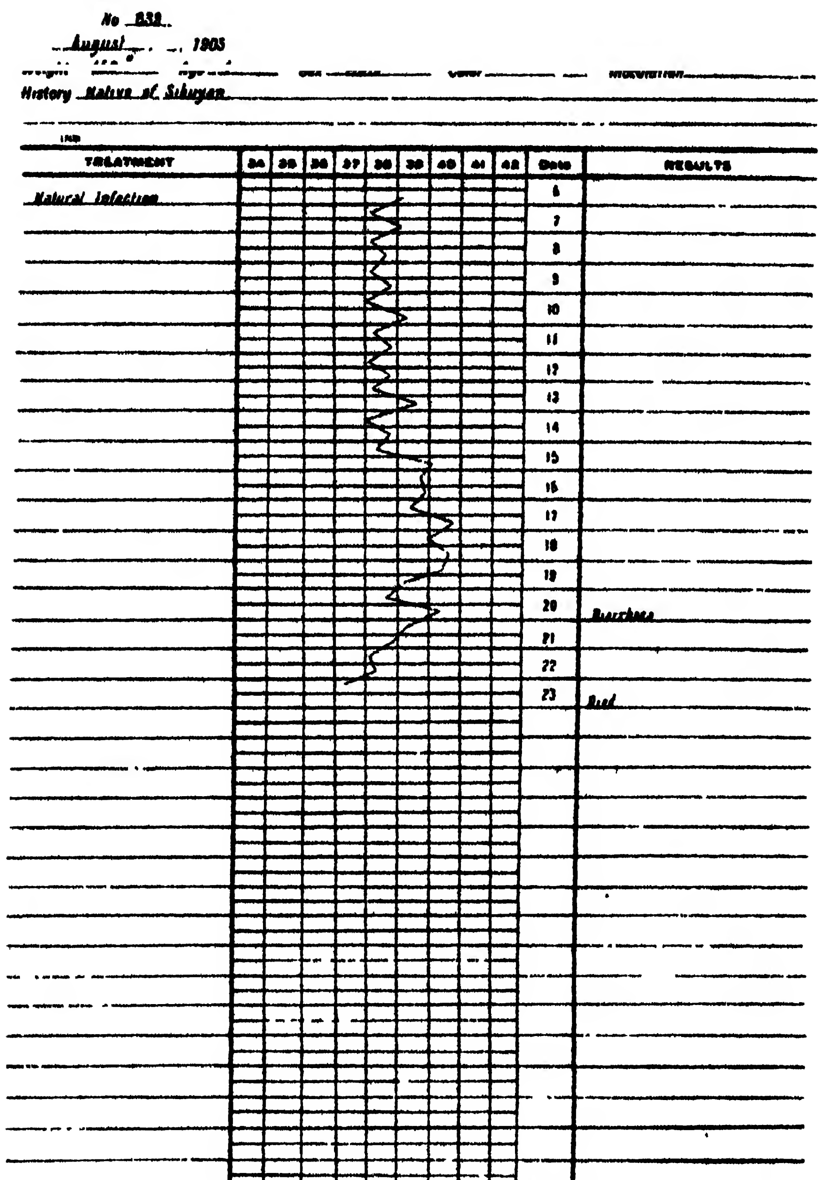

August
History Native of Sibuyan
TREATMENT
34
35
36
37
38
39
40
41
42
Date
RESULTS
Natural Infection
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Diarrhoea
21
22
23
Died

CHART No. 10.

No 332

December 1905

Weight 600 Age 4 Sex Male Color Inoculation

History Native of Babuyanes

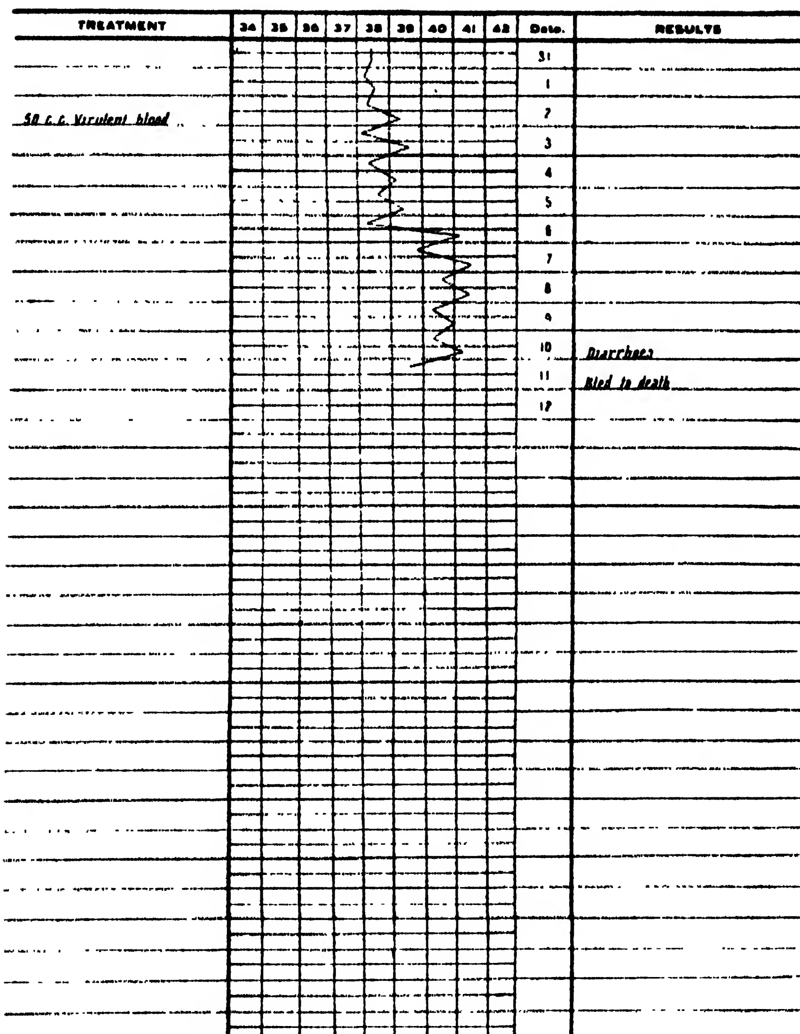


CHART No. 11.

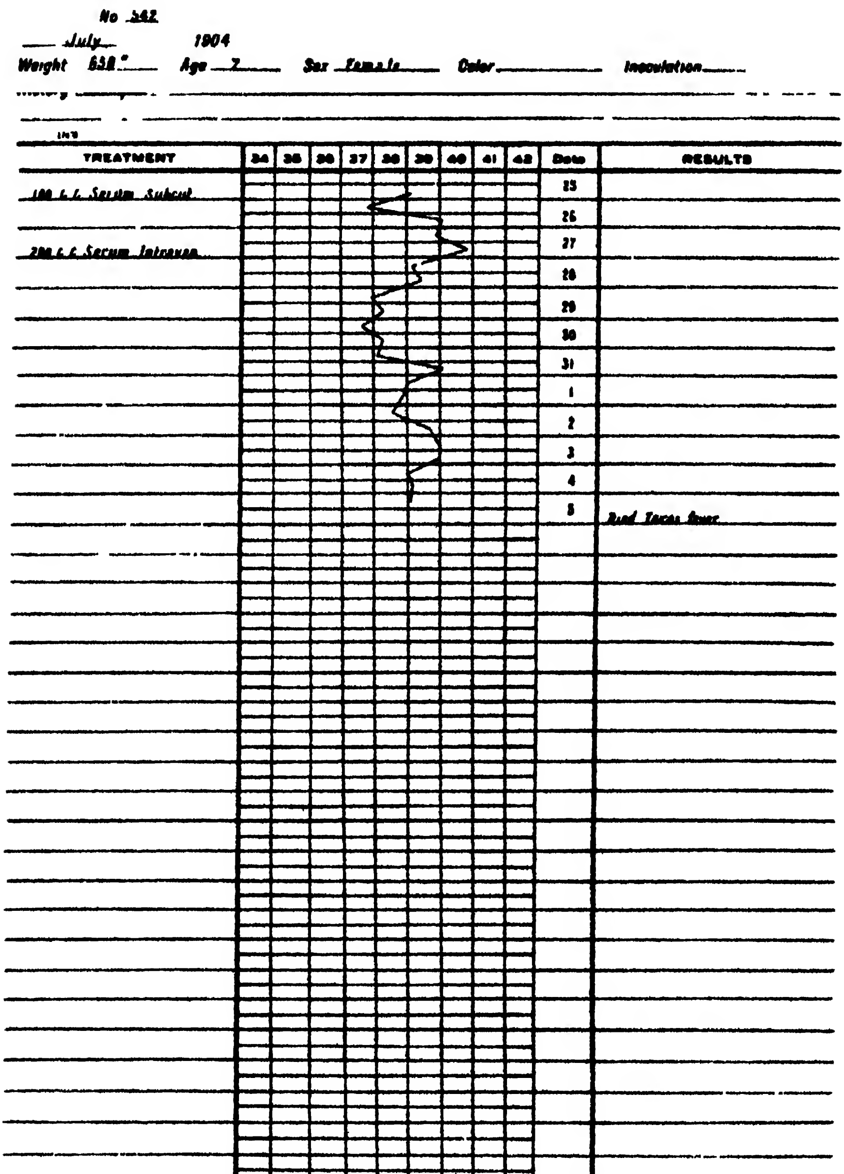

No 542
July 1904
Weight 630 Age 7 Sex Female Color Inoculation
TREATMENT
34 35 36 37 38 39 40 41 42
Date
RESULTS
100 c.c. Serum Subcut.
200 c.c. Serum Intraven.
25
26
27
28
29
30
31
1
2
3
4
5
Died Texas fever

CHART NO. 12.

No 921
— December . 1905
Weight 1100 *Age* 5 *Sex* Male *Color* *Inoculation* 100 c.c. Serum Rec 2
History Australian steer

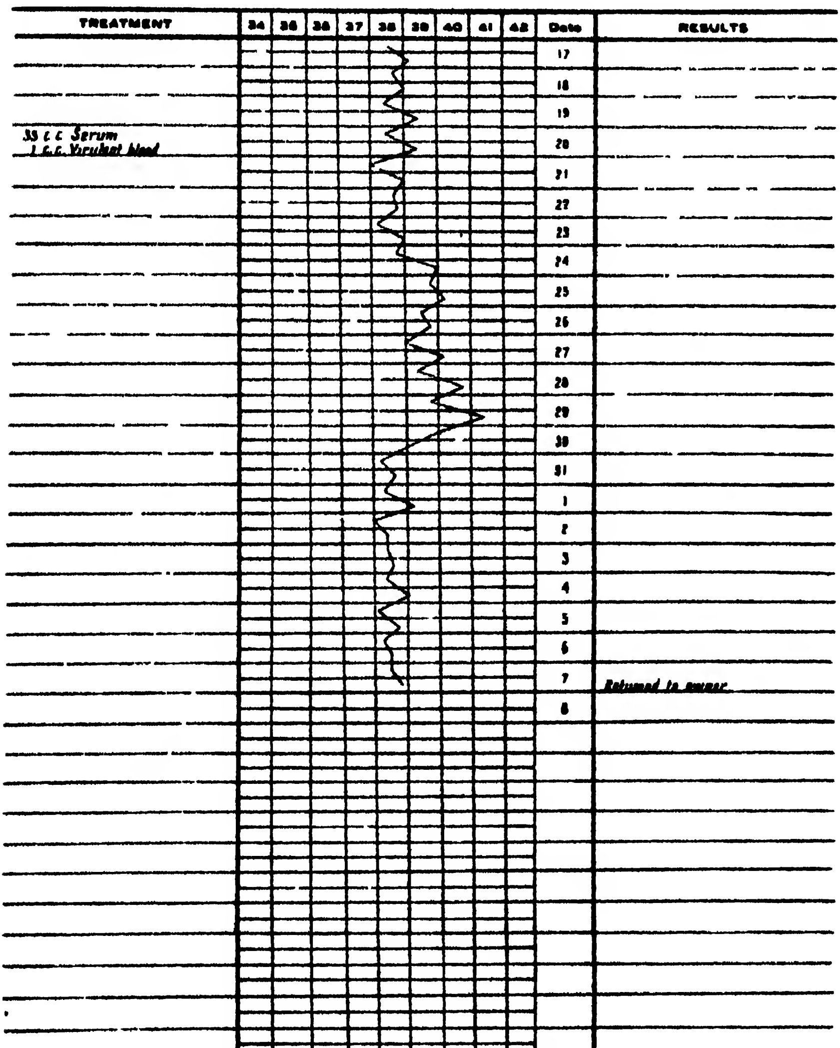


CHART No. 13.

No. 106

December 1905

Weight 75 Age 4 mos. Sex Male Color

History Australian Calf

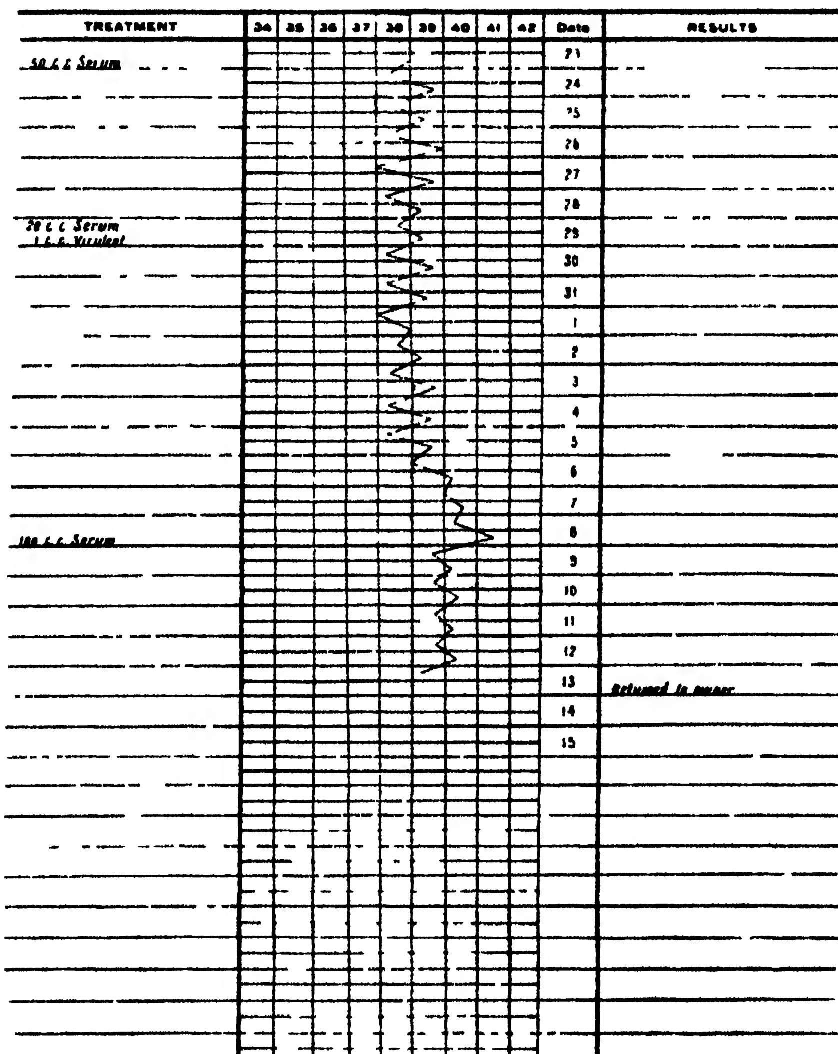


CHART NO. 14

No 10

September 1904

Weight — Age — Sex — Color — Inoculation —

History American Cow

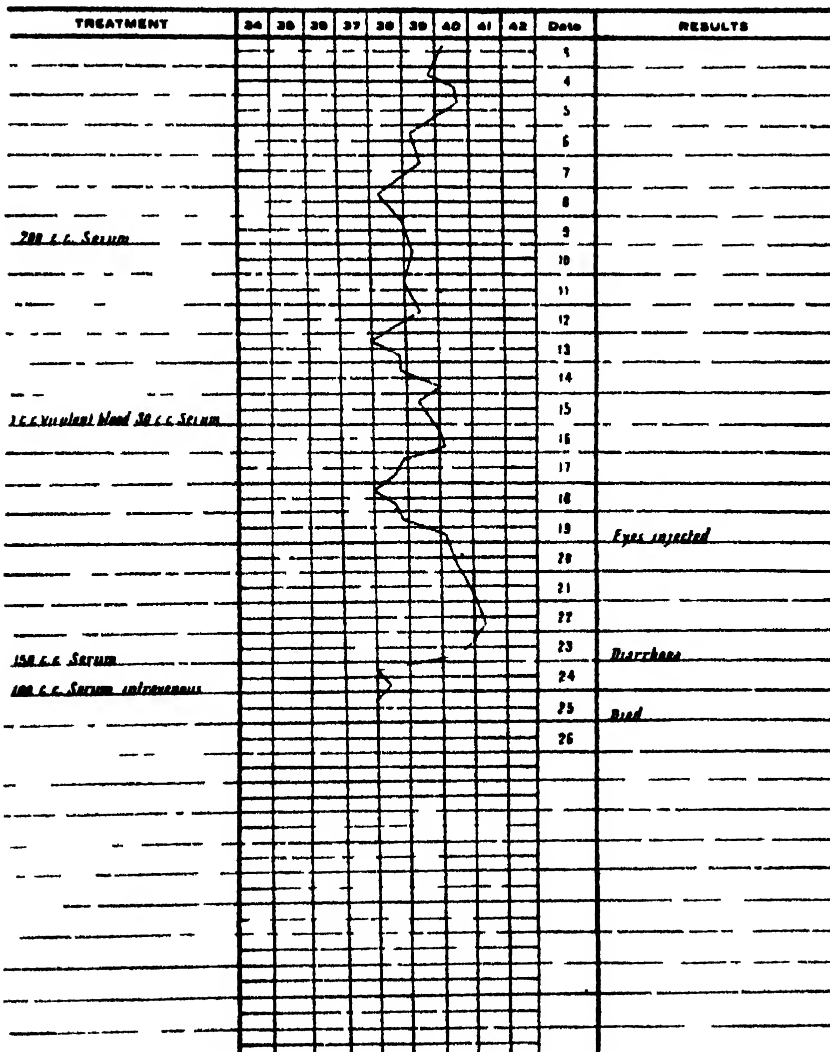


CHART No. 10

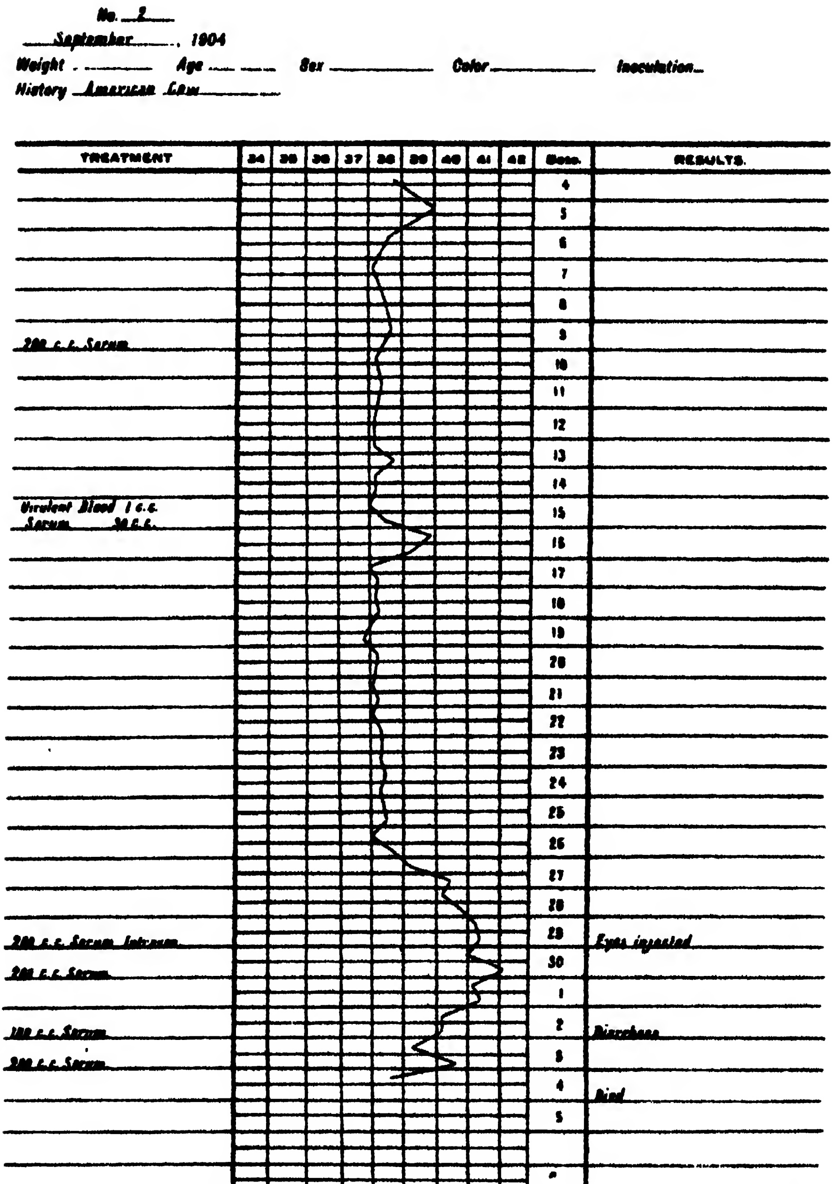

No. 2
September, 1904
Weight Age Sex Color Inoculation
History American Cow
TREATMENT
34 35 36 37 38 39 40 41 42
Date
RESULTS
4
5
6
7
8
9
200 c.c. Serum
10
11
12
13
14
Virulent Blood 1 c.c.
Serum 30 c.c.
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
200 c.c. Serum Intraven
Eyes injected
30
200 c.c. Serum
1
2
100 c.c. Serum
Diarrhoea
3
200 c.c. Serum
4
Died
5

CHART No. 16.

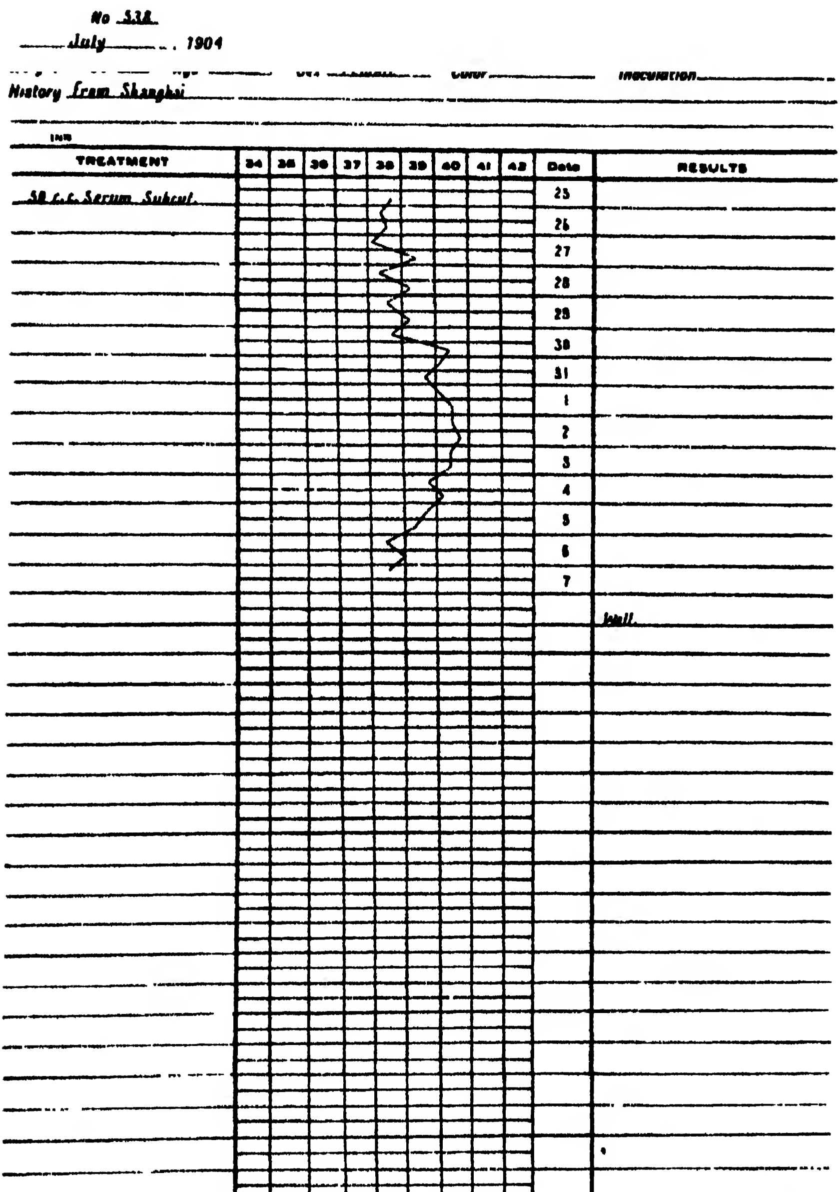

No 538
July 1904
Inoculation
History from Shanghai
TREATMENT
34 35 36 37 38 39 40 41 42
Date
RESULTS
50 c.c. Serum Subcut.
25
26
27
28
29
30
31
1
2
3
4
5
6
7
Well.

CHART NO. 17.

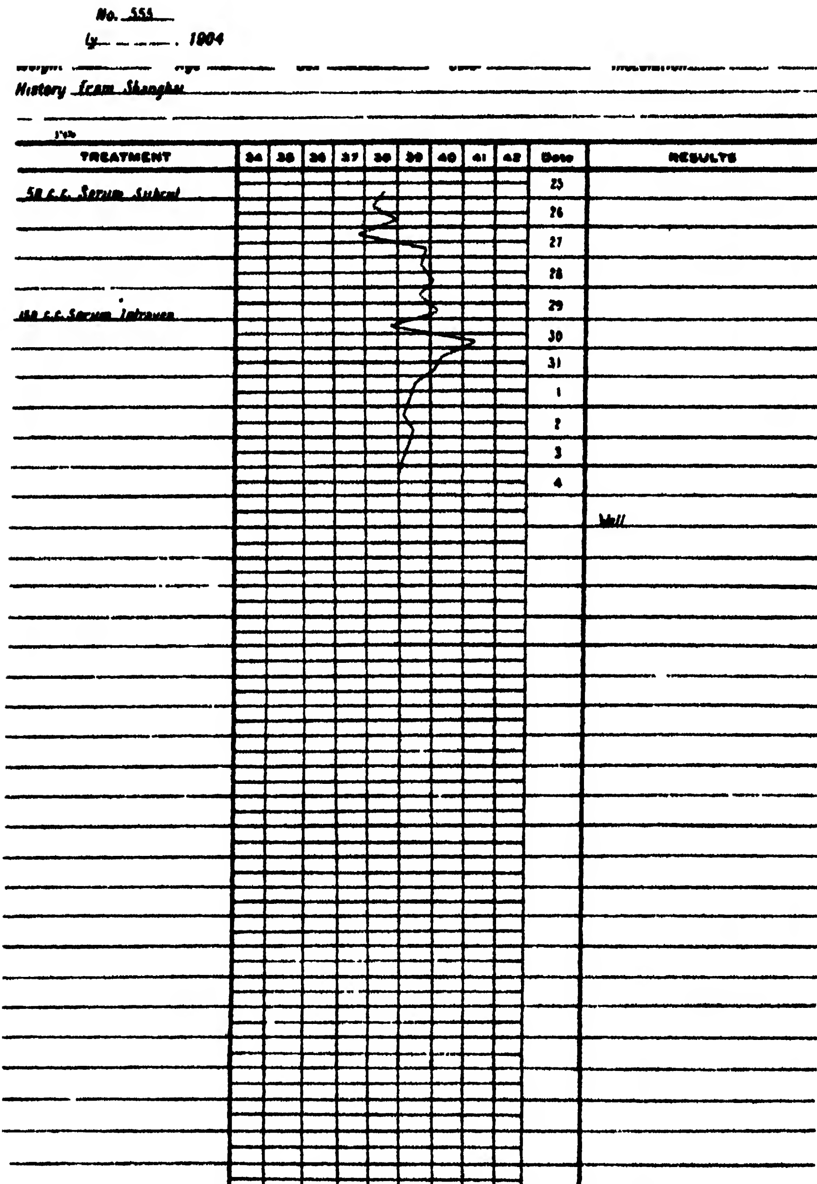

No. 555
1904
History from Shanghai
TREATMENT
34
35
36
37
38
39
40
41
42
Date
RESULTS
50 c.c. Serum Subcut
100 c.c. Serum Intraven
25
26
27
28
29
30
31
1
2
3
4
Well

CHART No. 18.

PRELIMINARY GEOLOGICAL RECONNAISSANCE OF THE LOBOO MOUNTAINS, BATANGAS PROVINCE.

By W. D. Smith

(From the Division of Mines, Bureau of Science, Manila, P. I.)

CONTENTS.

INTRODUCTION.

The writer, during portions of the months of August and September, 1905, was detailed from the Mining Bureau to make a preliminary geological inspection of the Loboo region where some prospecting was being carried on. Unfortunately, this reconnaissance was of necessity limited, but it is thought even the incomplete data already at hand should be made available. Furthermore, as very little literature and that not easily accessible to the public, can be found treating of this portion of Batangas Province, these notes may possess some utility at home, as well as scientific interest abroad.

The able Spanish engineer, Centeno,[1] has written of the Taal tuff deposits, which extend partly into the district discussed in this paper, but he extended his observations to a region no farther east than the pueblo of Batangas. Von Drasche[2] published some notes on the region of southeastern Luzon, but he likewise did not touch upon the Loboo country.

The field work done by the writer consisted primarily of an inspection

[1] J. Centeno: *Estudio geologico del Volcan Taal*, Madrid, Tello (1885).

[2] R. v. Drasche: *Fragmente zu einer Geologie der Insel Luzon*, etc., Vienna, Gerold's Sohn (1878).

of certain prospect work carried on by some prospectors from Batangas on a group of twenty-one claims in the Loboo Mountains, and trips east and west to the coast from these workings.

The site of these claims is indicated by crossed hammers on the general map (Pl. I), which has been adapted from d'Almonte. They are situated on the headwaters of the Calbasahan River in the pueblo of San Pedro, some 40 miles more or less from Batangas, and about 6 from San Juan de Bocboc.

The writer wishes to acknowledge the many courtesies and valuable assistance rendered by Messrs. Harris, Weeden, Weber, and others of this camp. Particular mention is due to Mr. Weber for the fossils shown on Plate IV, and for several compass route surveys which may be of considerable value in the future.

DISCUSSION.

Physiography.—The topography of this region is typical of mountainous country in the Philippines. The Loboo Mountains rise rather abruptly from a plain, with the steeper and shorter slopes to the east and south. Save for a considerable break where the Loboo River cuts through to the south, they extend as a chain continuously and approximately parallel with the coast. To judge from the trend of the range and this break, one might infer a fault with considerable horizontal displacement. However, no further indications of the latter have been seen. The mountains themselves exhibit nothing which materially differs from the usual erosion features of mountains in general; that is to say, they are not of the faulted block type, Karpathian or Jura, etc., although they approach more nearly the last. They attained their bulk and elevation from their particular mode of structure, which was that of a great anticline of stratified rocks pushed up from below, when the old, igneous stump slowly rose; following upon this rise there ensued the *growth* of the mountain topography by which they attained to their present accentuated relief.

The softer sedimentaries would produce rounded forms, while the more resistent igneous core would form the backbone of the range and stand up in peaks and sharp ridges.

Physiographically, the plain country possesses a particular interest. It is a plain of deposition, made up of heterogeneous materials, has a fairly even sky line and is being dissected by streams which run in deep gorges. As the writer went overland from Calamba, through Lipa to Batangas, he had a good opportunity to study the materials of this plain which on examination were seen to have been deposited in part from volcanic showers and in part by streams.

The country just east of Batangas, toward the Loboo Mountains, is an extension of the Taal tuff area. Its average elevation in the vicinity of the latter range is about 1,000 feet, but this increases gradually to

the north so that in the vicinity of Lipa it is between 1,500 and 2,000 feet. When one rides over this plain in any direction from the military road, he finds it to differ widely from the suggestion of apparent evenness obtained by a view from the highway. This old ash and tuff plain is at many points broken by deep gorges which may be 100 to 150 feet in depth, with almost vertical walls, veritable gashes across the landscape. Everywhere, signs of a very youthful stage of topography and of recent and rapid elevation of the plain are evident.

To the northward and westward of the Loboo region, lie the active and extinct volcanoes of Taal, Maquiling, Malarayat, and San Cristobal. These exhibit still another type of topography, which, however, lies outside the scope of this article.

In this region, then, we have three distinct types:

(1) That of the Loboo—that is, mountains which are not volcanic.

(2) The plain.

(3) The volcanic.

Drainage. The entire district is well watered, particularly so during the time of the writer's visit, which was in August and September. The records of the Antimonan meteorological station, which is the nearest thereto, show a total rainfall from July, 1904, to July, 1905, of 95.25 inches, the three months of greatest precipitation being September, October, and November. As there is no station at Batangas, data could not be obtained from that side of the range, but it is not probable that the Loboo Mountains afford a barrier which is sufficiently high and continuous to make the record materially different.

TABLE I.—*Meteorological data for Antimonan station, July, 1904, to July, 1905.*

Month	Mean temperature.	Average rainfall
	°C.	*mm*
July	28.0	54.8
August	28.0	141.7
September	26.8	423.9
October	27.0	556.2
November	26.0	636.2
December	25.5	166.3
January	25.5	73.5
February	25.6	35.0
March	27.2	10.1
April	27.2	231.2
May	28.8	77.6
June	28.0	112.4
Total		

The four principal streams of the region are the Calumpan, flowing into Batangas Gulf at Batangas; the Loboo, Rosario, or Pinacanauan, as it is variously called, debouching into the sea to the south near the pueblo of Loboo; the Lanay, or San Juan, emptying to the east near

San Juan de Bocboc; and the Calbasahan, the smallest of the four, heading in the vicinity of the district where the present prospecting is being carried on and flowing due east to the sea near Guinasepa. Although the actual flow of water has not been measured on the Calbasahan, it seems fairly certain that at all times of the year there will be a sufficiency to supply all of the ordinary mining needs, should such arise.

Good harbors are to be found near Batangas, in Batangas Gulf, and at Layan. The one at San Juan is inferior, because of its exposure in the time of the northeast monsoon. All this coast has been charted and can be more critically studied from the Coast and Geodetic chart, No. 4714.

Vegetation.—The Loboo Mountains are heavily clothed on both their east and west slopes with a forest growth, some of the trees being red and yellow narra (*Pterocarpus*), balete (*Ficus*), and the anahao palm (*Livistona*); these are all of goodly proportions and quite abundant, so that it will be easy to procure timber.

Large areas, on which the grasses taláhib (*Saccharum spontaneum*) and cogon (*Imperata exaltata*) run riot, are on the plains at the foot of the mountains; occasional sampaloc (*Tamarindus*) and antipolo (*Artocarpus*) trees are also seen.

General and local geology.—A summary of the general geology is as follows; it is shown in the ideal section on Plate II:

PROVISIONAL, TABULAR STATEMENT OF STRATIGRAPHY.

RECENT: Tuff and alluvial deposits.

PLEISTOCENE: Tuff deposits containing fragments of mammalian teeth.

PLIOCENE: Limestone fossils with Bornean affinities.

MIOCENE: Sandstone.

MIOCENE: Shaly sandstone containing *Vicarya callosa.*

UNCONFORMITY: Basal conglomerate.

PRE-MIOCENE: (Igneous) Diorite with quartz fissure-veins, cupriferous and auriferous.

The basement rock of the region is one to which the field name of diorite has been given—i. e., it has a granitic texture and contains plagioclase-feldspar and hornblende as primary minerals. In some places it was seen to verge upon a granite, in others it kept its strictly dioritic composition but became very decidedly gneissic. The rock as a whole is decidedly coarse grained.

It is in fissure veins which cut this rock, that the minerals of economic interest are found. As the diorite in this region is all more or less altered and stained with either iron or copper oxides and carbonates, considerable difficulty was experienced in obtaining a good sample from which to make a petrographic examination.

The diorite.—No. 1: Section of gneissic phase of diorite from one-half mile below Camp Cronk, pueblo of San Pedro, Loboo Mountains.

Megascopic. In the hand specimen, the rock is distinctly banded, the white bands consisting of plagioclase-feldspar; the dark ones of amphibole. It has a decided granitic texture. Striations on the plagioclases are easily seen. The average amphibole crystal measures from 2 to 4 millimeters in length.

The rock breaks with a rough fracture, but parts easily although somewhat unevenly, along the zone of the amphiboles.

Microscopic.—The rock, when examined in thin section, shows idiomorphic crystals of plagioclase by Michel-Levy's method of symmetrical extinction, determined mainly as labradorite, and actinolite (the grass green amphibole). The labradorite belongs to that portion of the series of plagioclase-feldspars which is characterized by the predominance of lime, and would be expressed by the formula Ab_3An_4.

It is very plainly seen in a number of places in the slide that there has been secondary granulation and cementation. This minute quartz filling is undoubtedly a part of the general and larger quartz cementation indicated more plainly in the quartz fissure veins of the region.

Although the nature of our work does not, at present, permit of petrographic study in great detail, a very rough attempt was made to classify this rock according to the quantitative classification given by Cross, Iddings, Pirsson, and Washington.[a] By this method, the proportion of salic to ferric minerals was found to be 84.32 to 15.70 per cent, and from further inspection of the mineral constituents, the writer has provisionally placed it in the subrang hessase of the Dosalane class, but measurements on several more slides and a chemical analysis would be necessary to make this classification entirely trustworthy. For the present and for the purposes of this paper the term diorite is sufficient.

The sedimentaries.—Above the igneous basement and best seen in canyons near the mountains, is a basal conglomerate of varying thickness with, in places, a shaly matrix, in others, coarse sandstone around pebbles and even large bowlders of dioritic rock. Because of limited sections, a thickness of more than 50 feet was nowhere to be seen, but if the observations of the writer in other parts of Luzon can be taken as a guide, it undoubtedly greatly exceeds this figure. This conglomerate we believe to be equivalent to that of the Agno and Bued river beds of Benguet, in those places in which the writer has studied it with A. J. Eveland, geologist, who has been working in that district.

A dark, coarse, sandy shale containing a suite of fossils having a decided Miocene aspect lies above the basal conglomerate. One of the latter is, in fact, *Vicarya callosa*, which, it may be said, represents one of the milestones of Philippine paleontology. This one characteristic form, together with the accompanying fossils, makes it almost certain that all the sedimentaries lying stratigraphically above it are at least younger than the Eocene. These questions will be considered more at length in the discussion of the paleontology which is to follow.

As erosion to a great extent has removed these beds and as the excessive formation of talus due to weathering has concealed a great part

[a] *Quantitative Classification of Igneous Rocks.* University Press, Chicago. 1903.

of those which remained, an estimate of the thicknesses of these formations without more detailed study is an extremely difficult one. This shale may have had any thickness between 100 and 1,000 feet. Minute lenticular seams of lignite and pieces of resin are occasionally seen therein.

A limestone, also of unknown thickness, lies above this sandy shale, and again, over the latter, a sandstone, but owing to limited time, no close investigation of the formations lying much above the shale horizon was made.

The fossils shown by Plate III were collected by the writer from the shale in the Loboo River; those on Plate IV by Mr. Weber, of Batangas, from the limestone, just above the latter, on the same stream. This limestone is of a dirty, cream color; it resembles some horizons in Cebú and occurs in rather thin, fissile beds.

A great thickness of most interesting deposits rests unconformably above these typically marine sediments. These, in all probability, are of volcanico-marine origin. The rock in this region is called dhobie by the American prospector, probably because he confuses it with the adobe from the western part of the United States, with which, however, it must not be confounded. The latter is generally an alluvial deposit derived from weathered basic igneous rocks, whereas the former for the most part is a tuff of volcanic origin, which has been blown out and deposited either in the sea or lagoons. Stratification is very pronounced in this Batangas deposit, which is not the case with the adobe of the Western States of America. However, the chief difference is to be found in the heterogeneous physical and mineralogical aspect of the former, yet the writer does not assert that there is no true adobe in this district: in fact, in the northern part, in the neighborhood of Mount Maquiling it occurs typically.

These tuff deposits exhibit very different facies throughout their great extent. In some localities they show a distinct stratification, while distant only a few feet, no sign of this can be seen. One stratum may be composed of extremely fine silt, with the layers above and below distinctly constituting a tuff which contains both fine and coarse materials. Fragments of pumice, obsidian, and round concretions of fine clay (lapilli) all may be encountered in one exposure.

A series of eight samples collected from an exposure near the city of Batangas by Mr. George Weeden, of that city, shows the variations in these deposits exceptionally well. All of these samples occurred in layers varying from 6 inches to several feet in thickness and cliffs of from 50 to 100 feet in height, and entirely composed of No. 7, have been seen.

The following is a brief summary of the lithological characters of the several beds, given in order from above downward:

No. 1: Fine grained, almost a mud, but slightly vesicular, and possessing distinct stratification. Color, gray. Dark specks, which are minute fragments of volcanic glass, are occasionally seen. It parts readily along the bedding plane.

No. 2: Differs very little from the preceding, perhaps a little finer grained.

No. 3: Much coarser than No. 2, made up of black and yellow angular fragments. Its matrix about the same as the body of No. 2. The black fragments, on being broken open, are seen to be dull in color, exceedingly fine grained, not glassy, but felsitic, also slightly vesicular. Occasionally an incipient sanidine crystal can be seen.

No. 4: Very coarse, but with practically the same composition as No. 3. Very loose and easily falling to pieces. Scoriaceous fragments more abundant.

No. 5: Dirty yellow in color, more coherent; concretions of fine yellow silty material occasionally seen. It contains fossil teeth, probably of *Bovida*.

No. 6: Practically the same as No. 3.

No. 7: Concretionary structure *very* pronounced. These concretions are usually almost perfectly round and vary from only a few millimeters to 10 or 20 centimeters in diameter. Concretions composed of the same material as the matrix.

No. 8: Appears altogether to lack the concretionary structure, at least this is so in the hand specimen; otherwise it differs in none of its essentials from No. 7. A slight efflorescence of a material which doubtless is sodium carbonate has appeared since the sample was received at the Bureau.

This admirable series shows the difference in the conditions which prevailed, but at present we are unable to give any reliable data as to the rapidity of change. Considerations of this kind, together with questions as to the origin of the series, etc., will, it is contemplated, be taken up by another member of this Bureau in connection with his work on Taal Volcano, with which these deposits are closely related.

This being the case, it is in this connection sufficient to state that the tuff-covered area as shown by Centeno on his map of the year 1885, extends beyond the limits given by the latter to the Loboo Mountain area and even to the eastern slopes of the range.

This deposit, or series of deposits, is in some places very recent, as is shown by the fossil rice blades, identical with those growing in the fields to-day, which occur in it, so that at least one mighty cataclysm probably took place within the historic period and at a time when this country had partly risen from the sea.

Reference to Plate II will suggest something of the field relations of the tuff obtaining in this region.

ECONOMIC GEOLOGY.

Considering the stage of the prospecting which is being carried on in this district, it might be premature to speak of the mineral veins as ore deposits. The country might be fairly well mineralized, without the occurrence of any workable body of ore.

For the most part, the metallic minerals are confined to veins of the fissure type, but some indications of lateral secretion in the country rock itself are present. Two sets of veins appear to be more prominent than the rest, the main one of these strikes in the direction of N. 70° W. whereas the other trends N. 45° to 57° W. By comparing the former direction with the general trend of the Loboo Range (see map, Pl. II) it is seen that the two agree very closely.

The gangue material of these veins varies, being for the most part quartz and a rock which owing to its altered condition has so far eluded any satisfactory classification. This second vein-stuff is greenish in color with brown specks of about one-third of a millimeter in diameter throughout the gangue. The writer is of the opinion that this rock is porphyritic, the phenocrysts having decomposed to give the rusty-brown specks. We were unable to work out the relation of this second type to the quartz veins at the time of our visit to the district. Whether or not they branch off from the former is not as yet determined, so that this highly important point is left for future solution. The widest quartz vein which was seen, measured from 4 to 6 feet where it was opened up on the "Maze" claim; however, the average thickness of these veins as seen in the present workings and outcroppings is not over 1 foot.

About one mile down the Calbasaban River from Camp Cronk and up a small tributary of the latter, termed Arizona Creek, a ledge was encountered which in places more nearly resembled a pegmatite than anything else, although on its borders it graded into the country rock, becoming coarser grained and more abundant in the ferromagnesian minerals laterally. This ledge measured 10 feet in width. The surrounding rock is decidedly gneissic. It is approximately vertical and strikes N. 70° W. A sample taken from a cutting across the whole face on assay showed only a trace of gold and 0.04 per cent of copper.

Many of the veins in this district are vertical, but a number which have a varying dip of from 30° to 89° exist and in this locality this dip almost invariably is to the west.

The following is a list of the minerals of economic value occurring in these veins:

1. Azurite.	5. Cuprite.	9. Molybdenite.
2. Bornite.	6. Malachite.	10. Proustite.?
3. Chalcocite.	7. Melaconite.	11. Silver.
4. Calcopyrite.	8. Gold.	

The black oxide of copper seems to be the chief mineral of economic value, although bornite in some places holds out good prospects. One streak about two inches wide was exposed in a tunnel in the "Reina Victoria" claim of Mr. Montague, which gave the highest values found in this district. As this streak has every appearance of widening out into a healthy vein, further development at that place might not be amiss.

As a rule the minerals occur in little patches and pockets throughout the localities visited by the writer.

Molybdenite was found to a certain extent associated with copper minerals, but confined more closely to the gneissic zone. It was nowhere seen in workable quantities. However, its discovery is very interesting as it is believed this is the first authentic report of molybdenite from the Philippine Islands.

Assays—Previous to the writer's visit a small number of samples had been sent to this Bureau for analysis. They gave exceedingly favorable results, and upon this basis a provisional estimate of the probable cost of mining and treatment of these ores was made for the prospectors in that district. However, this estimate was held over until further sampling had been done and some study of the region completed. The writer regrets that the results of the assays and of the personal examination of the district do not induce us to place any great confidence in the earlier sampling and reports from the camp in that region. However, negative determinations are often as valuable from a commercial standpoint as are positive ones and therefore we shall here give the results of both samplings to show what erroneous ideas may be deduced concerning a district even when it is the effort of the interested parties to be perfectly honest, for the latter often mislead themselves as badly as they do those who are on the outside.

Two tables (Nos. II and III), giving results of analyses follow, the former of ores collected by prospectors and forwarded to this Bureau, the latter of samples taken by the writer and assayed by the same.*

Table II

Number	Gold	Silver	Copper
			Per cent
[illegible]	Color	Trace	7 67
[illegible]	0 4 oz $8 27		10 56
3	Color	Trace	4
4			17

Table III

Number	Gold oz	Gold value	Copper
			Per cent
1	Trace		0 08
2	0 05	$1 08	1 24
3	18	3 72	2 21
4	Trace		07
5	02	11	22
6	06	1 24	26 21
7	Trace		61
8	Trace		10
9	Trace		03
10	Trace		1 1
11	Trace		04
[illegible]	Trace		14

*All assays are by Paul J. Fox, of this Bureau, to whom the thanks of the writer are due.

These samples were all taken according to the most approved methods adopted by mining engineers and the strictest impartiality and caution were observed.

From a limited examination, the best prospects at present are seen to be the vein outcropping at the point from which sample No. 3, Table III, was taken and the thin but rich streak where No. 6, Table III, was secured. Both of these are, in the opinion of the writer, well worth further development work. The ledge which yielded No. 3, from its peculiar character, trace of values and width, might well be given attention.

The gold ore is in part free milling, as some of it was crushed and panned, but for the greater part, it is believed, it will prove to be refractory.

Claims and titles.—In this district there are twenty-one claims staked out at the present time, although, to the writer's knowledge, no patents have been issued. Because nothing beyond prospecting and assessment work is being carried on in this place, an existing plat of the claims is not published at this time; the latter shows the courses of the various veins, but owing to the exceedingly crude and in some cases inaccurate compass surveys it would only be misleading.

This portion of the discussion will be concluded with the statement that the work so far done on the mineral resources of the Loboo region is too meager to allow us either to condemn it or to be carried away with an exaggerated enthusiasm. The region, we firmly believe, merits further exploration, but beyond that we do not presume to advise.[5]

PALEONTOLOGY.

INTRODUCTION.

Although only a small number of fossils are to be described in this paper, nevertheless this is the first instance in which they have been encountered in this district. They have, of themselves, a peculiar interest and also a bearing on certain economic questions, and finally, their affinities with forms from neighboring parts of the Malay region warrant their full discussion.

To the writer's knowledge, no fossils have been figured or described from this portion of Luzon. A knowledge of them is absolutely essential for the complete and proper understanding of the relations of the stratified deposits and of the latter to the igneous rocks. At present, any economically valuable mineral deposits which may occur are likely in the first instance to come from the igneous basement, but occurrences, small to be sure, of lead and gypsum in the sedimentary formations appear to promise future values from these higher horizons and in the

[5] Since writing the above, specimens of very good looking copper ore (chalcocite), galena, and stibnite have been brought in from the Loboo Mountains near Batangas city. The country is, to say the least, well mineralized.

delimitations of the latter, fossils play their most important part. Furthermore, in this district as well as farther north in Luzon, some small amount of prospecting has been done for coal and upon this subject some deductions resulting from the study of the fossils of the several districts and which may be found to possess practical value, can be made. Concrete examples are always more convincing than abstract statement. One may be given as follows: In all the coal fields visited by the writer in Batan and Cebu islands, the coal seams have been found to lie stratigraphically *below* the Upper Miocene beds. Now, in the Batangas district, as well as farther north in several localities, we have found beds with an Upper Miocene fauna resting just *above* the igneous base. This means that the Lower Miocene, Oligocene, and Eocene are missing and from this, in turn, the conclusion must be reached that coal beds corresponding to those of Batan, Polillo, and Cebu are wanting in many of these localities. Great care should be taken in interpreting this statement, which does not mean that coal will not be found in northern Luzon, for it is known to occur in the Zambales Range and in the Cagayan Valley. On Plate III the most typical of these Upper Miocene fossils are figured and these may be used as indicators.

Description of Species.

ZOÖPHYTA.

Fungidæ.

CYCLOSERIS M. E. & J. H.

Cycloseris hidalgi sp. nov. Pl. IV, fig. 1.

C. f. C. decipiens Mart., Tertiärschicht. auf Java. *Pl. XXV, fig. 3, p. 143.*

Thickness, 5 millimeters; diameter, 58 millimeters. Circular, with radiating septa arranged in cycles. I VI. Number of principal septa, 48.

Thin, upper surface convex, slightly depressed in the center.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

Eupsammidæ.

BALANOPHYLLIA.

Fig. 2 (Pl. IV) is a photograph of a very poor specimen, from the same bed as that in which *Cycloseris* was found, which I have provisionally called a *Balanophyllia*.

FORAMINIFERA.

ORBITOIDES d'Orb.

Description of genus. Test discoidal, with circular or stellate contour, often bent, exterior smooth or with radial striæ, and composed of numerous concentric annuli disposed about a primordial spiral of three to five whorls. The rings are divided by transverse partitions into small, rectangular chambers and the septa and marginal cord are traversed by canals. Superimposed over the median series of the principal chambers on both sides are several layers of flattened secondary chamberlets, which are likewise disposed in concentric rings. (Zittel.)

Orbitoides martini sp. nov. Pl. IV, figs. 6, 7, and 9.

Specimen with edges somewhat broken. Disc-shaped, with slight protuberance in the center; often found bent and warped, rarely perfect. Surface perfectly smooth. Section (fig. 9) shows no central chambers larger than usual, as is the case in some species of orbitoides. Chambers in the median line lozenge-shaped and with their long axes at right angles to those of the chambers in the outer cycles. Diameter of individuals varies from 15 to 50 millimeters.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

Similar forms are plentiful in the limestones of Cebu, above the Coal Measures.

GASTEROPODA.

TURBO Linn.

Turbo borneënsis Bttg. Pl. IV, figs. 3 and 4.

Turbo borneënsis Böttger., Die Eocänformation von Borneo. *Pl. I, figs. 3 and 4, p. 11.*

These are casts of individuals which are almost identical with those figured by Böttger, though they are a trifle smaller. Height, 15 millimeters; diameter of bottom whorl, 25 millimeters. These casts are very abundant both in Batangas Province and in Cebu.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene in the Philippines, though it is found in the Eocene in Borneo.

Fig. 11, Plate IV, is probably a young specimen of this same species.

NERITA Linn.

Nerita punctata sp. nov. Pl. IV, fig. 8.

Thick ovoid, or semiglobose, imperforate. Surface marked by rows of small nodes which are arranged perpendicular to the lines of growth. The figure on Plate IV shows this specimen at natural size.

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

DRILLIA Gray.

Drillia (?) (Pleurotoma) weberi sp. nov. Pl. IV, fig. 10.

Imperfect specimen which has been provisionally classified as *Drillia* from a comparison with *Drillia allioni* Bell, from the Miocene of Baden, Austria. As very few of the generic, to say nothing of specific, characters can be made out on our specimen, this must remain with an interrogation attached to it.

CYPRÆA Linn.

Cypraea paniculus? Bttg. (young form).

Cypraea paniculus Böttger. Die Eocänformation von Borneo. *Pl. III, fig. 23, p. 22.*

Fig. 12 shows the size of this specimen, which is probably the young of *paniculus.*

Locality: Limestone on Loboo River, Batangas Province.

Age: Younger Miocene.

VICARYA d'Arch.

Vicarya callosa Jenk. var. **semperi.**

Vicarya (?) callosa Jenk. Quart. Jr. Geol. Soc., Vol. XX, *Pl. VII, fig. 5, p. 57.*

Vicarya callosa Jenk. Tertiärschichten auf Java, Martin. *Pl. XI, fig. 3, p. 62.*

Vicarya callosa Jenk. Sammlungen des Geologischen Reichsmuseums in Leiden, Vol. V, 1896, pp. 53, 69.

Also noted in Japan and India, but we are unable to give citations of the literature.

Fig. 1, Plate III, is a photograph (slightly enlarged) of a rather imperfect specimen, but which still shows enough of the sculpturing to enable us easily to identify it as belonging to this species. As the shaly sandstone from which it was taken was exceedingly hard, the specimen suffered unavoidable mutilation.

This Batangas fossil is somewhat larger than those figured by Martin from Minanga and Dicamui brook in Luzon, but is about of the size of a specimen which the writer examined in the museum of the Imperial University at Tokyo, Japan. It is also of nearly the same dimensions as that described by Martin from Java.

The characteristic features of all these specimens are the flattened whorls, the row of strong spines which are found next to the sutures, the sigmoidal growth lines which have their deepest incurvation between the rows of spines.

The Batangas specimen possesses at least 10 whorls, its length is 88 millimeters, width 3.5 millimeters, and the angle of spire is 27°.

Locality: Loboo River, Batangas Province.

Age: Upper Miocene.

STROMBUS Linn.

Strombus javanus Martin, var. nov. **semperi.** Pl. III, fig. 3.

Strombus javanus Martin. Tertiärschicht. auf Java. *Pl. IX, fig. 2, p. 47.*

As this is a cast a very close comparison with Martin's figure can not be made, and it is probable that, were the outer shell present, this would be found to be not even a variety. At present the only difference is in the shape of the whorls, those of the Batangas specimen being more rounded. The fluting on the margin of the expanded lip can be seen very plainly. Height, 30 millimeters; width of bottom whorl, including expansion of lip, 19 millimeters.

Locality: Loboo River, Batangas Province, in shaly sandstone just above igneous basement.

Age: Upper Miocene.

Fig. 13 is a cast undetermined, but which is found in great numbers in the same beds with *Vicarya callosa.*

TAPES Megerle.

Tapes (?) lobooënsis sp. nov. Pl. III, fig. 2.

This cast has the *Tapes* outline and area of *Tapes*. Length, 30 millimeters; height, 18 millimeters.

So far as we know, this is the first instance of the finding of this genus in the Philippines, and therefore we assign to it the specific name given above, although we recognize its poor claims to the rank of a type.

Locality: Shaly sandstone beds of Loboo River, Batangas Province.

Age: Upper Miocene.

Tapes sp. indet. *Pl. III, fig. 7.*

Another poor cast of a fairly common form in same bed with *T. loboocnsis.*

PTEROPSIS Conr.

Pteropsis (?) bullata sp. nov. Pl. 3, fig. 5.

This is a fairly perfect cast of a very globular species of what we take to be *Pteropsis*. The heavy growth lines appear to be very characteristic and in this species each ridge is made up of two and sometimes three minor ridges. The

right valve is slightly larger than the left. Length, 25 millimeters; height, 21 millimeters.

Locality: Shaly sandstone beds of the Loboo River, Batangas Province.

Age: Upper Miocene.

MACOMA Leach.

Macoma rosariana sp. nov. Pl. III, fig. 4.

The cast of a very triangular form with a rapidly descending anterior margin, marked by a prominent sinus parallel to this edge.

The figure does not at all bring out the sculpture, but there is enough on the cast to enable any one examining it to make out the rather prominent growth lines to be seen as small ridges from 2 to 3 millimeters apart. Length of shell, 43 millimeters; height, 34 millimeters.

This form is not greatly unlike *M. nasuta* Carp. from the Upper San Pedro series (Pleistocene), Los Cerritos, California.

It is quite difficult in these casts to distinguish between *Tellina* and *Macoma*. In this case, the writer has considered the more triangular and blunter shape and the rougher surface as indicating the latter rather than the former.

Locality: Shaly sandstone beds of the Loboo River, Batangas Province.

Age: Upper Miocene.

ARCA Lam.

Arca nodosa Mart. var. nov. **batanensis.** Pl. III, fig. 6.

Shell trapezoid, equivalve, with a wide amphidetic area, distant conspicuous beaks, and radial sculpture, a wide byssal gape, a long, straight, transversely dentate hinge line, with many similar teeth. (Zittel.) This shell, which is the commonest form in the Tertiary as well as the Recent deposits of these Islands, is quite similar to Martin's *A. nodosa*, however with the nodes not so prominent. It measures 20 millimeters in length, 11 millimeters in height, and the number of ribs is 22. The nodes are found only on the lateral ribs.

Locality: Shaly sandstone beds on Loboo River, Batangas Province

Age: Upper Miocene.

The variety name of *batanensis* has been given because of the great abundance of this form in the beds above the Coal Measures on Batan Island, P. I.

The writer has not as yet seen any living form which is quite like this. The living species are all much larger. The *Arcidæ* are still the most abundant of our Philippine marine mollusca.

LUCINA Brug.

Lucina sp. indet. Pl. III, fig. 8.

A cast of a species, as yet undetermined, with very prominent beaks. A portion of the shell, still remaining, possesses a very fine sculpturing consisting of parallel growth lines.

Locality: Shaly sandstone beds on Loboo River, Batangas Province.

Age: Upper Miocene.

SEMELE Schum.

Semele (?) dalli sp. nov. Pl. IV, fig. 5.

This specimen is somewhat more triangular than the *Semelidæ* usually are, but its sculpturing and the possession of a shallow sinus parallel to the anterior margin make it resemble the form described by Dr. Dall in his "A Subtropical

Miocene Fauna in Arctic Siberia." *Proceed. U. S. Nat. Museum,* Vol. XVI, pp. 471–478.

Locality: Limestone beds on Loboo River, Batangas Province.

Age: Younger Miocene.

Table No. IV presents in brief the writer's present knowledge of the distribution and relationships of the fossils described and figured. It is well understood that much more might be stated if a completer acquaintance with the literature were possible. As paleontological work in other portions of the Islands is in progress, it is deemed best at the present time to forego further comment on the material here presented.

TABLE IV.—*Showing relationship and distribution of the Batangas fossils.*

No.	Name of fossil.	Plate.	Found in Tertiary of adjacent countries.	Relationship.	Localities in Philippines.
1	Vicarya callosa[a] Jenk	III	Java, Japan (Miocene.)	Vicarya verneuili D'arch. (Miocene of India).	Batangas Province, Cebu, and northern Luzon.
2	Tapes loboensis sp. nov.	III		Tapes rimosa Phil. (Miocene, Java).	Batangas.
3	Strombus javanus Mart. var. Semperi var. nov.	III		Strombus javanus Mart. (Miocene, Java).	Do.
4	Macoma rosariana sp. nov.	III		M. nasuta Conrad (Pleistocene, California).	Do.
5	Pteropsis? bullata sp. nov.	III			Do.
6	Arca nodosa var. bataneusis.	III		A. nodosa K. Mart. (?) (Miocene, Java).	Batan Island; Batangas.
7	Tapes sp. indet	III			Batangas.
8	Lucina sp. indet	III		Similar casts in Benguet and Cebu.	Do.
9	Cycloseris hidalgi sp. nov.	IV		C. diciplens Mart. (Miocene, Java).	Batangas; Benguet.
10	Balanophyllia hyllia	IV			Batangas.
11	Turbo borneënsis Bttg.	IV	Borneo (Eocene)		Batangas; Benguet in Luzon and Cebu.
12	Semele (?) dalli sp. nov.	IV			
13	Nerita punctata sp. nov.	IV		N. rumphi Recluz (Miocene, Java).	
14	Orbitoides martini sp. nov.	IV	The genus is distributed from New Hebrides to Japan.		Cebu; Batangas.
	...eberi, sp. nov.	IV			Batangas.
	pauiculus? Bttgr.	IV	Borneo (Eocene)		Do.

[a] *Cerithium nodulosum* living in Philippine waters is probably closely related to *V. callosa.* Likewise *C. vulgatum* from southern Europe, West Africa, and Cape of Good Hope.

ILLUSTRATIONS.

PLATE I.

Diagrammatic section across portion of Batangas Province.

PLATE II.

General map of portion of Batangas Province, showing the Loboo Mountains (from d'Almonte).

PLATE III.

(All figures slightly enlarged.)

1. *Vicarya callosa* Jenk.
2. *Tapes loboonensis* sp. nov.
3. *Strombus javanus* var. *semperi* var. nov.
4. *Macoma rosariana* sp. nov.
5. *Pteropsis? bullata* sp. nov.
6. *Arca nodosa* var. *batanensis*
7. *Tapes?* sp. indet.
8. *Lucina* sp. indet.

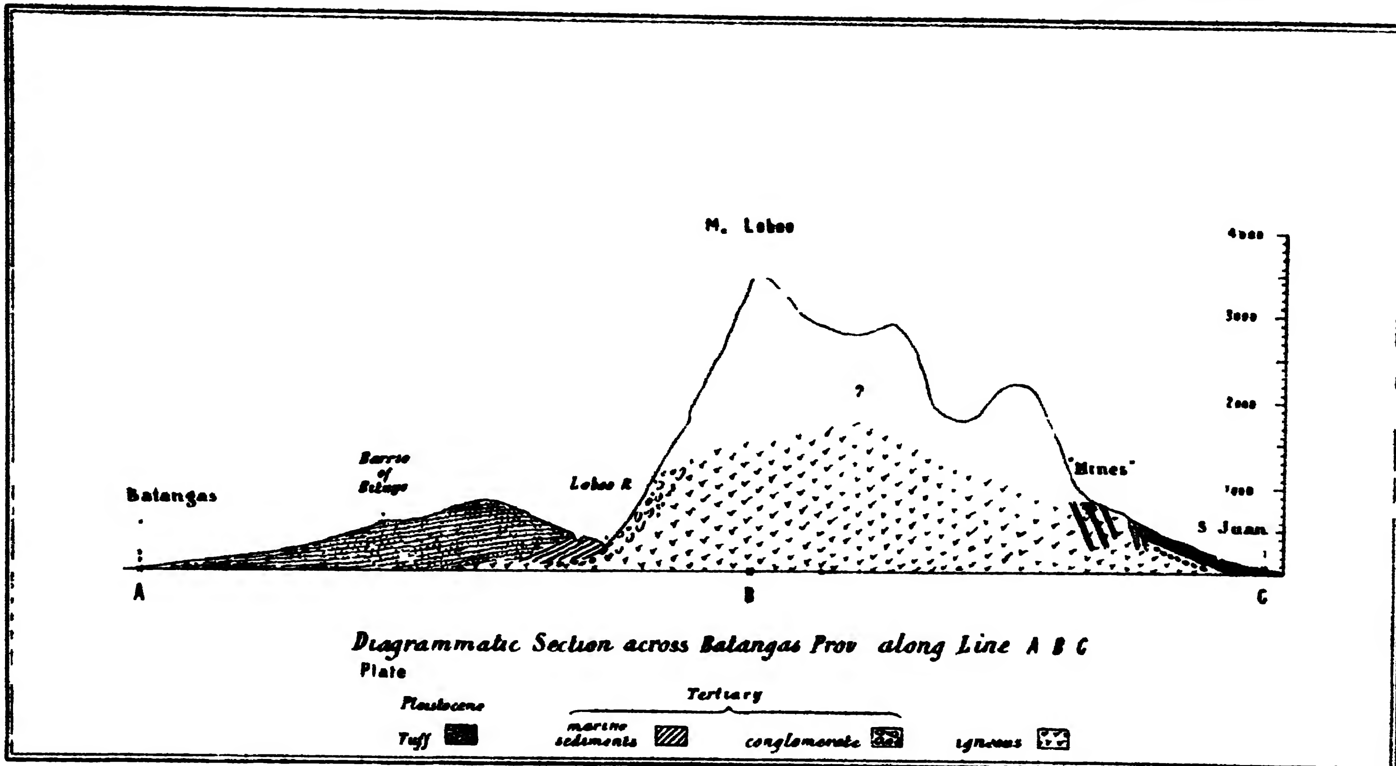
PLATE IV.

(All figures slightly enlarged.)

1. *Cycloseris hidalgi* sp. nov.
2. Indet. (one of the *Eupsammidae*)

3, 4. *Turbo borneensis* Bttg.

5. *Semele* (?) *dalli* sp. nov.
6. *Orbitoides martini* sp. nov.
7. *Orbitoides martini* (end view).
8. *Nerita punctata* sp. nov.
9. *Orbitoides martini* (enlarged six diameters, from drawing).
10. *Drillia weberi* sp. nov.
11. *Turbo borneensis* (young form).
12. *Cypraea paniculus* (young form).
13. Internal cast of *Vicarya?*



Diagrammatic Section across Batangas Prov along Line A B C

PLATE I

PLATE II.

PLATE III

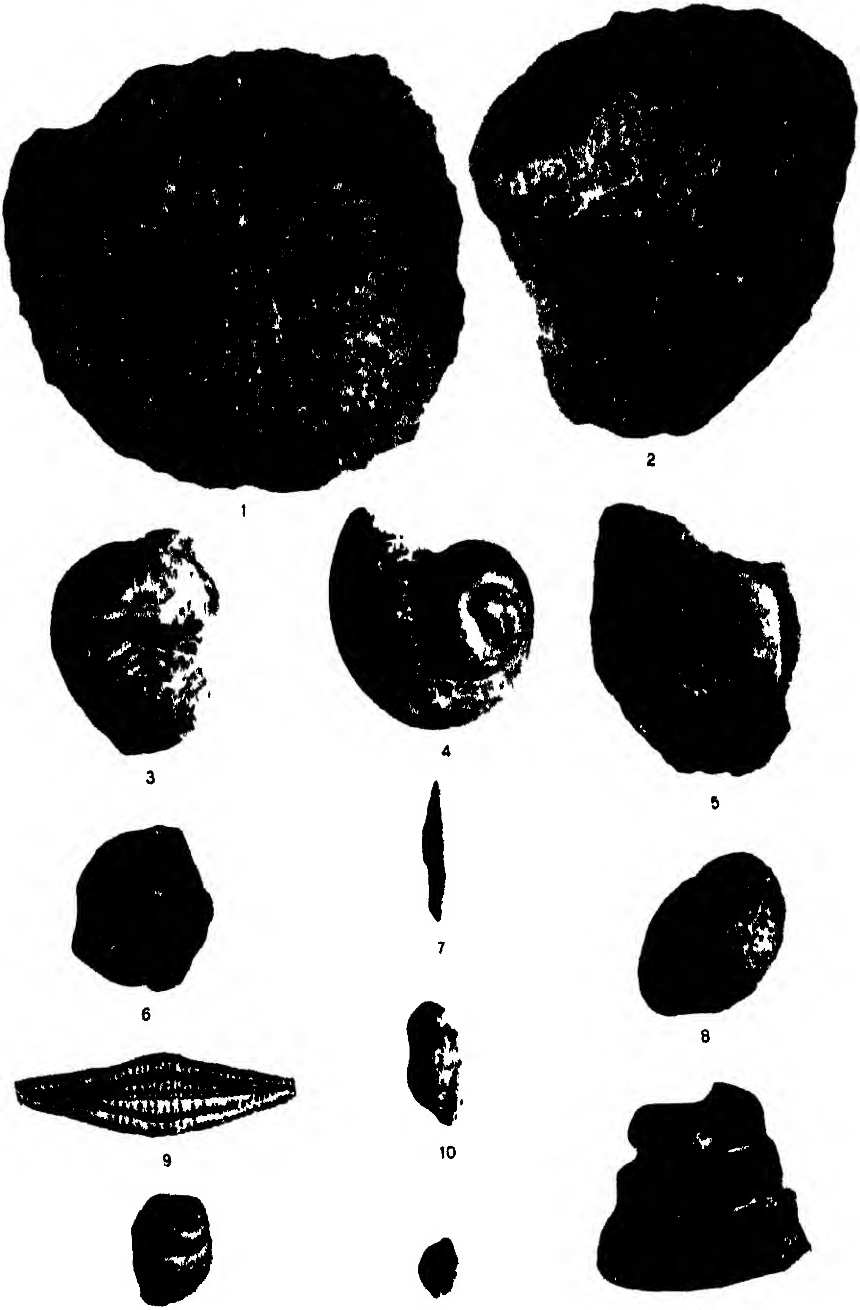


PLATE IV

THE VEGETATION OF THE LAMAO FOREST RESERVE, II.

(CONCLUDED FROM PAGE 431.)

By H. N. WHITFORD.

(From the botanical section of the Biological Laboratory, Bureau of Science.)

III. THE DIPTEROCARPUS-SHOREA FORMATION.

On the south side of the Reserve there is a characteristic type of vegetation between the two hundred and fiftieth and four hundred and fifth meter contour lines; on the north, as shown by the map, the type almost entirely disappears. Over 15 per cent of the trees belong to one species, *Dipterocarpus grandiflorus* (apitong). So characteristic is this species that it was thought advisable to separate the forest where it is encountered into a distinct formation, giving it the name of the two principal species of *Dipterocarpaceæ* which are found there. (Pls. XXIV and XXVIII.)

Description of Table XVII.[43]

The plot is situated at an altitude of 340 meters. It is on the top and slopes of a ridge and comprises an area of approximately 8.325 square meters.

TABLE XVII.

Name of plant.	A.	B.
1. Dipterocarpus grandiflorus	182	15.7
2. Shorea polysperma	134	11.5
3. Memecylon edule	94	8.1
4. Aporosa sphaeridophora	81	7.0
5. Ternstroemia toquian	66	5.7
6. Diospyros pilosanthera	59	5.1
7. Santiria nitida	52	4.5
8. Calophyllum wallichianum	46	4.1
9. Shorea contorta	41	3.5
10. Cyclostemon microphyllum	30	2.6
11. Eugenia glaucicalyx	26	2.2
12. Cinnamomum mercadoi	23	2.0
13. Aporosa symplocosifolia	22	1.9
14. Semecarpus perrottetii	22	1.9
15. Hopea acuminata	20	1.7
16. Quercus sp.	17	1.6
17. Kayea paniculata	15	1.3
18. Litchi philippinensis	15	1.3
19. Plectronia viridis	12	1.0
20. Euphoria cinerea	12	1.0
21. Shorea guiso	12	1.0

[43] The data upon which Table XVII is based were gathered by T. E. Borden, inspector in the Bureau of Forestry.

TABLE XVII—Continued.

Name of plant.	A.	B.
22. Ellipanthus luzoniensis	10	(*)
23. Symplocos oblongifolia	10	
24. Vatica mangachapoi	10	
25. Baccaurea tetrandra	10	
26 Eugenia sp	8	
27. Pandanus luzonensis	8	
28. Anisoptera vidaliana	6	
29 Calophyllum whitfordii	6	
30. Gonocaryum tarlacense	6	
31. Ormosia calavensis	6	
32. Knema heterophylla	6	
33. Excoecaria philippinensis	5	
34. Dimorphocalyx longipes	4	
35. Kopsia longiflora	4	
36 Litsea luzonica	4	
37 Litsea fulva	4	
38. Myristica philippensis	4	
39. Sideroxylon duclitan	4	
40. Talauma villariana	4	
41 Antidesma edule	3	
42. Ficus sp	3	
43. Aglaia harmsiana	2	
44. Champereia cumingiana	2	
45. Eugenia sp	2	
46 Eugenia sp	2	
47. Grewia stylocarpa	2	
48 Mangifera altissima	2	
49 Pygeum latifolium	2	
50. Shorea sp	2	
51. Sterculia brevipetiolata	2	
52. Linociera sp	2	
53 Unona clusiflora	2	
54. Aglaia bordenii	1	
55. Albizzia procera	1	
56 Ardisia philippinensis	1	
57. Artocarpus communis	1	
58. Buchanania florida	1	
59. Citrus hystrix		
60. Cyathocalyx globosus		
61. Dipterocarpus vernicifluus	1	
62 Ficus sp	1	
63 Guioa sp	1	
64. Ixora sp	1	
65. Ixora sp	1	
66. Memecylon sp	1	
67. Michelia parviflora	1	
68 Mitrephora ferruginea	1	
69. Pahudia rhomboidea	1	
70. Palaquium tenuipetiolatum	1	
71 Randia sp	1	
72 Shorea sp	1	
73 Voacanga sp	1	
74 to 85 (unknown species)	12	
Total (85)	1,160	

* The following have less than 1 per cent.

Description of Table XVIII

This table covers four plots in various situations in the *Dipterocarpus-Shorea* formation. A, a plot of 600 square meters situated at the junction of the main ridge with a side one at an altitude of 410 meters. B, a plot in a partially open place on a ridge at an altitude of 330 meters; it comprises 450 square meters. C, a plot of 750 square meters at the junction of a side ridge with the main one at an altitude of 300 meters. D, a small plot comprising 300 square meters at 200 meters' altitude on a gentle slope. E, total number of trees of each species in all the plots. F, percentage of the same.

TABLE XVIII

	Name of plant	A	B	C	D	E	F
1	Dipterocarpus grandiflorus	12	1	28	30	71	18 4
2	Calophyllum wallichianum	8	4	27	3	42	10 9
3	Shorea polysperma	11	5	11	–	34	8 8
4	Shorea contorta	3	11	6	1	21	5 4
5	Santiria nitida	7	[illegible]	1		17	4 4
6	Diospyros pilosanthera		[illegible]	8	6	15	8 8
7	Litsea fulva	1	7	–		15	3 8
8	Anisoptera vidaliana		2	7	4	13	3 3
9	Baccaurea tetrandra	6	2	2	3	13	3 3
10	Cinnamomum mercadoi	–	2	8		12	3 1
11	Cyclostemon microphyllum		2	9		11	2 8
12	Semecarpus perrottetii		3	1		8	2 0
13	Conocarpum tarlacense		4	3		7	1 8
14	Eugenia glaucicalyx	1	1	4	1		
15	Hopea acuminata	1	3	1	1	[illegible]	1 5
16	Euphoria cinerea	3		–			1 3
	Kopsia longiflora						1 3
18	Ormosia calavensis	3				5	1 3
19	Atalantia disticha	1	1	–	0	[illegible]	1 0
20	Aporosa sphaeridophora	4				4	1 0
21	Dipterocarpus vernicifluus		–			4	1 0
22	Ellipanthus luzonensis	1	2	1		4	1 0
23	Kayea paniculata	–			2	4	1 0
24	Myristica philippensis		3	1		4	1 0
25	Unona clusiflora	2		2		4	1 0
26	Aporosa symplocosifolia	1	2			8	(*)
27	Buchanania florida	3				3	
28	Dimorphocalyx longipes			3		3	
29	Grewia stylocarpa	1	1	1		3	
30	Litchi philippinensis		2	1		3	
31	Neolitsea vidalii			1	2	3	
32	Aglaia bordenii	2				2	
33	Casearia cinerea		2			2	
34	Eugenia sp			2		2	
35	Eugenia sp		2			2	
36	Litsea luzonica	1	1			2	
37	Palaquium tenuipetiolatum	1			1	2	
38	Parkia roxburghii		2			2	
39	Plectronia sp			2		2	
40	Quercus sp	2					
41	Reinwardtiodendron merrillii	2					
42	Strombosia philippinensis	2					

*Less than 1 per cent

TABLE XVIII—Continued.

Name of plant.	A.	B	C	D.	E.	F.
43. Zizyphus zonulatus		2				
44 Antidesma edule	1					
45 Casearia fuliginosa		1				
46. Champereia cumingiana						
47 Eugenia sp						
48 Ficus ruficaulis		1				
49 Garcinia binucao						
50 Mangifera altissima		1				
51 Mitrephora lanotan						
52 Pithecolobium acle		1				
53 Pygeum latifolium						
54 Talauma villariana		1				
55 Ternstroemia toquian		1				
Total	88	92	147	61	388	

It will be seen from Tables XVII and XVIII that three members of the *Dipterocarpaceæ*, namely, *Dipterocarpus grandiflorus*, *Shorea polysperma*, and *S. contorta*, comprise 31.6 per cent of all the trees in the plots measured. With the exception of *Calophyllum wallichianum*, *Santiria nitida*, *Eugenia glaucicalyx*, and a few others, these trees make up nearly the whole of the upper story vegetation. Attention has already been called to the fact (see p. 120) that in this formation these trees in places form a similar crown class and that in correspondence with this there is a less development of board roots. (See Pl. XXIV.)

Trees which may reach a crown class slightly lower than the *Dipterocarpaceæ* are *Ternstroemia toquian*, *Diospyros pilosanthera*, *Litsea sp.*, *Cinnamomum mercadoi*, and others. Prominent, because of the three striking board roots, is *Eugenia glaucicalyx*. (See Pls. XXII and XXVIII.) A reference to the tables descriptive of the other formations will show that with the exception of *Dipterocarpus grandiflorus* all the species found in this one are also present in others. In this plot *Parkia roxburghii*, with two trees, reaches its highest altitude. *Albizzia procera*, another species of the *Bambusa-Parkia* formation, is likewise represented by one specimen and the upper limits of *Pterocymbium tinctorium* and *Pithecolobium acle* are also found.

On the other hand, species which become more prominent in the next formation higher up the mountain are introduced for the first time. Prominent among these are *Ternstroemia toquian*, *Plectronia viridis*, *Symplocos oblongifolia*, and *Excoecaria philippinensis*. In this formation *Anisoptera vidaliana* occupies a subordinate position and it entirely disappears from the forests a short distance above its upper limits.

The presence of *Dipterocarpus grandiflorus* in a narrow belt at this altitude, where it becomes the most important tree, is undoubtedly due to more favorable climatic conditions than exist below this altitude. Why

it should not be represented by more specimens lower down [44] and why it disappears almost entirely on the ridge leading to Limay Peak is not known. The explanation of its scarcity in the latter locality is probably correlated with the extension of the *Bambusa-Parkia* formation higher up the mountain in this situation. That the heat of the low country is not too great for it to flourish is evidenced by the fact that on the east coast of Luzon, where the dry season is less pronounced, it descends nearly to sea level.

The topography of this formation is similar to that of the previous one discussed—i. e., it shows alternating prominent ridges and valleys. With the exception of its non-occurrence on the steep slopes, where the vegetation is thin and in the beds of the river canyons, *Dipterocarpus* itself is not confined to any particular topographic type. At the extreme upper limits of the apitong zone is a sharp knob where all the soil has been washed off, leaving the half-disintegrated volcanic rock exposed on the surface. On this area, out of 60 trees noted, 18 were *Quercus sp.;* 11, *Vatica mangachapoi;* 10, *Shorea polysperma;* 9, *Eugenia pallida;* 5, *Symplocos oblongifolia*, and the remainder *Dipterocarpus grandiflorus, Ternstroemia toquian, Aporosa symplocosifolia*, and *Plectronia viridis*. All these species in this situation have much reduced leaves and the trees show a tendency to become dwarfed. This plot is the lowest place which was observed on the mountain, where exposure to wind dwarfs the trees of the forest. The climbing bamboo (*Dinochloa tjankorreh*) is characteristic on the open places on steep slopes. No other bamboos are present in the formation. Young trees of the *Dipterocarpaceæ* with *Memecylon edule, Aporosa sphaeridophora, Diospyros pilosanthera, Uraria alba, Claoxylon rubescens, Codiaeum luzonicum, Leea philippinensis, Litsea luzonensis, Dracaena angustifolia*, and *Tabernaemontana pandacaqui* form the undergrowth.

In its response to the xerophytic conditions of the dry season, this formation differs from the *Anisoptera-Strombosia* one in having fewer deciduous trees. Isolated specimens of *Parkia roxburghii* are about the only individuals which shed their leaves completely during a portion of the dry season, but nearly all the trees show a thinner foliage. *Dipterocarpus grandiflorus* completely changes its leaves during January and February, but simultaneously with the dropping of the old, new ones take their place. At this season of the year the thick bed of dead leaves on the ground, the large, red, bud scales appearing with the new leaves and the large, sweet-scented flowers of this species accentuate its numerical importance. The ground itself is so completely covered with fallen foliage that this characteristic, together with the thin undergrowth, reminds one strikingly of the forests of temperate regions in the autumn. Plates XXIV and XXVIII will give some idea of the gen-

[44] Only one was noted in the *Anisoptera-Strombosia* formation and none were observed above an altitude of 450 meters.

eral appearance of the forest. In its other ecological characteristics the *Dipterocarpus-Shorea* resembles the *Anisoptera-Strombosia* formation.

Summary.—1. Over 30 per cent of the *Dipterocarpus-Shorea* formation is composed of members of the *Dipterocarpaceæ*.

2. Corresponding with the greater rainfall, less saturation deficit and less heat, this formation, in contrast with those lower down the mountain side, is less xerophytic. This is shown by the almost complete absence of deciduous trees and by the greater leaf display among the evergreens during the dry season.

3. The formation, as a whole, has a more regular profile.

4. In other ecological respects the formation resembles the *Anisoptera-Strombosia* formation.

5. For the first time a topographical situation is encountered where exposure brings about a tendency to dwarf the trees—a tendency which finds its best expression on the exposed ridges higher up the mountain.

IV. Shorea-Plectronia Formation.

In striking contrast with the formation in which over 30 per cent of the larger tree species are members of the *Dipterocarpaceæ* is the one immediately above it in which this family is represented by only 16 per cent of the total number of trees over 4 meters in height. Again, an under story vegetation is represented by a number of species. Among the larger of these, the genus *Shorea* stands first and the rubiaceous *Plectronia viridis* is typical of a number of about the same height and having the same ecological characteristic—that is, an ability to withstand a considerable amount of shade, and therefore this has been called the *Shorea-Plectronia* formation. In extent it lies approximately between the 450 and 900 meter contour lines. Its upper limits are marked by a rather sudden restriction of the *Dipterocarpaceæ*.

Description of Table XIV.

Plots in Shorea Plectronia formation. A, a plot on a level bench of a side ridge leading from the main ridge to the Lamao river. It comprises an area of 675 square meters. B, a plot starting at an altitude of 675 meters and running through a vertical distance of 30 meters. The slope is about 25° and the area 1,440 square meters. It is on the same ridge as A. Plots C, D, E, F, and G, each extending through a vertical distance of 30 meters, represent portions of a narrow side ridge leading directly to the river at right angles to the one on which are A and B. C, is on a slope of 42° and has an area of approximately 252 square meters; D, on a gradient of 40° and with an area of 336 square meters; E, one of 44°, and it represents an area of 360 square meters; F, is a still steeper slope of 45° on a narrow ridge between two ravines. It has an approximate area of 250 meters. A canyon to the right of it has a depth of 18 meters with perpendicular sides. G, is on a very steep and unstable slope (over 45°); it has an estimated area of 300 square meters and ends at the junction of two canyons. The first line tabulates trees over 4 meters in height; the second, those under 4 meters; H, is the total of trees over, and I of those under 4 meters; J, represents the percentage in all plots of trees over 4 meters.

TABLE XIX.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
1. Plectronia viridis	10 8	43 11	20 9	25 13	17 22			115	43	11.5
2. Shorea polysperma	8	16	20 7	28	23	6	1	101	Many.	10.1
3. Memecylon edule	13 9	41	5 5	1	2 9	1		61	Many.	6.1
4. Calophyllum whitfordii	4 3	16	8	17 8	9 6	2 8	1	57	Many.	5.7
5. Aporosa simplocosifolia	3 1	16 4	5 1	11 12	10 19	5 7	3 1	53	45	5.3
6. Hopea acuminata	8 3	10	4 3	6 6	10 12	4	1	43		4.3
7. Thea montana	2 3	25 22	1 12	6 10	6 10	1		41	57	4.1
8. Quercus sp.	2 5	7	5	17	5		1	37	Many.	3.7
9. Eugenia glaucicalyx	11	17	1	2	1	1		33	Many.	3.3
10. Ternstroemia toquian	5	8 4	2	8	5 10	2	4	32	16	2.3
11. Shorea contorta	1 4	15 5	5 5	1 1	1		2 1	25	16	2.5
12. Acer philippinum	1	3 5	11 22	6 25	8 10	1 2		29	45	2.4
13. Eugenia acuminatissima	4 5	5 4	6	2 6	1 7	1	5	23	23	2.3
14. Cinnamomum mercadoi	2 4	3 2		7 2	4	1		17	8	1.7
15. Cyclostemon microphyllum	2 2	10 2	1		3 1	1		17	5	1.7
16. Symplocos oblongifolia		2	2	9 8	3 7			16	15	1.6
17. Unona clusiflora	3	7 5	1 8	1	3 2			15	15	1.5
18. Aporosa sphaeridophora		11 7	2	2 4				15	11	1.5
19. Diospyros pilosanthera	1	7 3	1 2		1 4	2	3 6	14	16	1.4
20. Ardisia marginata	6 5	4 5	3 9	2	2	2	4	13	20	1.3
21. Casearia solida		1					11 13	12	13	1.2
22. Crypteronia cumingiana					3	7	2	12	1	1.2
23. Buchanania florida				1	2 2	3 1	5 1	11	4	1.1
24. Baccaurea tetrandra			1		1 1	1 1	8 8	10	11	1
25. Semecarpus perrottetii					5 3	3 3	2 3	10	9	1
26. Itea macrophylla					5 5	5 2		10	7	1
27. Eugenia pallida	2	7 1	3		1			10	4	1
28. Santiria nitida	1	4	1	1	1	1 1		9	1	.9
29. Eugenia sp	4 3	3 1			1			8	4	.8
30. Antidesma? sp.	4	3 4	1 1					8	5	.8
31. Agathis philippinensis	3	3 1		1 1	1			8	2	.8
32. Eugenia cinnamomea							7 1	7	1	.7
33. Glochidion sp					3	4		7		.7

TABLE XIX—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
34. Guioa perrottetii	2	4	1 2	2 2	2 5	1		6	15	0.6
35. Dipterocarpus vernicifluus	2	4 4						6	4	.6
36. Gordonia fragrans	1	8	2					6		.6
37. Ellipanthus luzoniensis			1	8			1	5		.5
38. Eurya acuminata			8	1 4	1			5	4	.5
39. Polyalthia barnesii							4 5	4	5	.4
40. Eugenia sp.				4 8				4	8	.4
41. Eugenia bordenii			1		2	1 2		4	2	.4
42. Eugenia whitfordii		2 1					2 1	4	2	.4
43. Timonius arborea					3	1 1		4	1	.4
44. Litsea luzonica	4	2 9			2	1	1	3	16	.3
45. Astronia rolfei						3		3	Many	.3
46. Polyosma philippinensis	2	1 8	1					3	4	3
47. Symplocos ferruginea	2 1			1	1			3	2	3
48. Englehardtia subsimplicifolia				2 1	1			3	1	3
49. Randia whitfordii	1						3	3	1	.3
50 Eugenia sp.						1	2	3		.3
51. Euphoria cinerea						2	6	2	6	.2
52. Randia fitzalani		1 1	1		1			2	2	.2
53. Podocarpus blumei		1 3					1	2	3	.2
54. Eugenia sp.					2 1			2	1	.2
55. Champereia cumingiana		1		1	1			2	1	.2
56. Canarium villosum						2		2		.2
57. Atalantia disticha		1	1					2		.2
58. Myrica rubra		1		2 1				2	2	.2
59. Endiandra coriacea							2	2		.2
60. Arthrophyllum ahernianum					2			2		.2
61. Pygeum latifolium	1					1		2		.2
62 Helicia philippinensis					2			2		.2
63. Palaquium tenuipetiolatum		1					1	2		.2
64 Cyclostemon monospermus	2							2		.2
65 Aglaia bordenii							2 3	2	3	.2
66 Scolopia luzonensis		1		1				2		.2

TABLE XIX—Continued.

Name of plant.	A.	B.	C.	D.	E	F.	G.	H.	I.	J.
67. Linociera coriacea		1				7	1	1	8	0.1
68. Euphorbiaceæ sp						1 5		1	5	.1
69. Casearia cinerea							1 2	1	2	.1
70. Antidesma lucidum			1 1					1	1	.1
71. Garuga floribunda					1 1			1	1	.1
72. Knema heterophylla	1	1						1	1	.1
73. Litchi philippinensis							1 1	1	1	.1
74. Litsea sp	1	1	1					1	2	.1
75. Planchonia spectabilis							1 1	1	1	.1
76. Antidesma leptocladum							1	1		.1
77. Ardisia boissieri					1			1		.1
78. Eugenia sp							1	1		.1
79. Ficus sp						1		1		.1
80. Ficus hauili				1				1		.1
81. Ficus sp	1							1 1		1 .1
82. Laportea luzonensis							1	1		.1
83. Nauclea philippinensis					1			1		.1
84. Pavetta barnesii		1						1		.1
85. Machilus philippinensis	1							1		1
86. Saurauia subglabra					1			1		.1
87. Shorea guiso							1	1		.1
88. Turpinia pomifera							1	1		.1
89. Villebrunea trinervis						1		1		.1
90. Unknown species										
91. Unknown species			2							.2
Total	111	805	118	168	172	68		100		100.0

Description of Table XX.

These plots are in various physiographic situations in the *Shorea-Plectronia* formation. A is in the basin at the head of a ravine, one side of which is open. The plot is on a very slight slope, comprises an area of 770 square meters and is at an altitude of 528 meters. B is on the main ridge leading to the mountains, here the ridge is broad, with a gentle slope; the plot has an area of 640 square meters and is situated at an altitude of 570 meters. C is on an exposed slope of the main ridge, with an incline of 25°. It has an area of about 610 square meters and is at an altitude of 500 meters. D is on a level ridge at an altitude

of 400 meters and comprises an area of approximately 620 square meters. E, totals; F, percentage.

TABLE XX.

Name of plant	A.				E.	
1. Diospyros pilosanthera				4		7.9
2. Shorea contorta				18		7.6
3. Litsea luzonica			1	2	17	5.2
4. Calophyllum whitfordii			10	2	15	4.6
5. Memecylon edule			8		15	4.6
6. Cinnamomum mercadoi			3	8	14	4.3
7. Shorea polysperma	7		2	4	13	4.0
8. Baccaurea tetrandra	8	2		2	12	3.7
9. Ternstroemia toquian		5	5	1	11	3.4
10. Santiria nitida	4	1	3	2	10	3.1
11. Eugenia sp	9				9	2.7
12. Aporosa sphaeridophora	1	1		6	8	2.4
13. Litsea sp			1	3	8	2.4
14. Ardisia boissieri			2	1	7	2.1
15. Calophyllum wallichianum			1	3	7	2.1
16. Eugenia sp	5					2.1
17. Hopea acuminata	1		1			
18. Plectronia sp		4	3		7	2.1
19. Thea montana			7		7	2.1
20. Eugenia acuminatissima		5			6	1.8
21. Plectronia viridis					6	1.8
22. Semecarpus perrottetii		3		3	6	1.8
23. Eugenia sp					5	1.5
24. Pheanthus cumingii				4	5	1.5
25. Aporosa symplocosifolia		2			4	1.2
26. Dipterocarpus vernicifluus					4	1.2
27. Acronychia laurifolia		3			3	(*)
28. Cryptocarya luzoniensis		3			3	
29. Eugenia cinnamomea						
30. Gonocaryum tarlacense			1	2	3	
31. Kayea paniculata	1			2	3	
32. Quercus sp.	1			2	3	
33. Symplocos elmeri		1		2	3	
34. Unona clusiflora		2		1	3	
35. Buchanania florida			2		2	
36. Dysoxylum turczinanowii					2	
37. Goniothalamus sp		2			2	
38. Lagerstroemia speciosa	2				2	
39. Laportea luzonensis						
40. Neolitsea vidalii		1		1	2	
41. Podocarpus blumei		2			2	
42. Tabernaemontana pandacaqui	2				2	
43. Vatica mangachapoi			2		2	
44. Aglaia bordenii	1					
45. Antidesma edule	1					
46. Ardisia philippinensis				1	1	
47. Atalantia disticha			1		1	
48. Anisoptera vidaliana			1		1	
49. Casearia solida		1				
50. Champereia cumingiana			1			
51. Cyclostemon microphyllum						
52. Dimorphocalyx longipes						

* Less than 1 per cent.

TABLE XX—Continued.

Name of plant.	A.	B.	C.	D.	E.	F.
53. Eugenia sp	1				1	
54. Eugenia sp				1	1	
55. Eugenia glaucicalyx			1		1	
56. Fagara integrifoliola				1	1	
57. Helicia philippinensis		1			1	
58. Litchi philippinensis			1		1	
59. Euphorbiaceae sp	1				1	
60. Mangifera altissima	1				1	
61. Linociera coriacea		1			1	
62. Podocarpus neriifolius		1			1	
63. Pygeum latifolium				1	1	
64. Sterculia brevipetiolata				1	1	
65. Shorea guiso				1	1	
66. Sideroxylon duclitan			1		1	
67. Tarrietia sylvatica			1		1	
Total					327	

Composition of the forest.—An examination of Tables XIX and XX will show that among the trees of the upper crown class the *Dipterocarpaceæ*, represented by *Shorea polysperma*, *S. contorta*, *Hopea acuminata*, and scattered specimens of *Dipterocarpus vernicifluus*, *Anisoptera vidaliana*, *Shorea guiso*, and *Vatica mangachapoi*, comprise about 16.5 per cent of all and reach to a height of 25 to 30 meters. Species of *Eugenia*,[45] although present in the lower formation, become more prominent in this one. In some instances they reach to the height of the dipterocarps, but usually they are considerably lower in stature; about 10 per cent of the forests are composed of species of *Eugenia* and among others having individuals of this class are *Quercus* (about two species), *Calophyllum whitfordii*, *C. wallichianum*,[46] *Santiria nitida*, *Agathis philippinensis*, *Gordonia fragrans*, and isolated specimens of other ones. *Agathis philippinensis* (almaciga) of the *Pinaceæ* reaches huge dimensions, being in many instances 40 meters in height and nearly 2 meters in diameter. (See Pl. XXV.)

Memecylon edule, *Diospyros pilosanthera*, *Aporosa symplocosifolia*, *Thea montana*, *Acer philippinum*, and *Litsea luzonica* are the principal representatives of the under-story species. Certain families, some of which are present in the lower formations, now occur with a greater number of species and individuals. Among these, species of *Rubiaceae* stand out prominently. Besides *Plectronia viridis*, which gives a decided tone to the undergrowth, there are *Timonius arborea*, *Randia whitfordii*, *R. fitzalani*, and *Nauclea philippinensis*, which reach a height of over 4

[45] The species of *Eugenia* are difficult to distinguish by leaf specimens, hence specific determinations have not been made in all instances.

[46] The two species of *Calophyllum* overlap each other in their distribution at the lower limits of this and the upper limits of the previous formation.

meters, although they seldom are taller than 8. *Rubiaceæ* which do not reach above 4 meters occur as scattered specimens of the genera *Knoxia* and *Urophyllum*, which are better represented on the exposed ridges at greater altitudes.

Besides the larger trees of the *Theaceæ*, namely, *Gordonia fragrans* and *Ternstroemia toquian*, the smaller one, *Thea montana* is very common as undergrowth. *Memecylon edule* of the *Melastomataceæ*, which is also conspicuously encountered in all three formations below that of the *Shorea-Plectronia*, is very common in this portion of the Reserve; indeed, here it reaches its best development in size and numbers.

Relation of the composition of the forest to topography.—The variation in the composition of the forest, just as is the case in the formations previously discussed (excepting in the parang types, which are due to artificial conditions), depends in the main on the physiographic situation. The topography in this situation is rougher than it is in the formations found at lower altitudes. This prevents the vegetation from reaching the luxuriant condition which it would have in a similar climate but with a more stable topography; that is, at a point nearer base level with its accompanying conditions. Again, as compared with lower situations, the higher altitude of this formation renders any exposed position more subject to the influence of winds, and thus a tendency toward a dwarfed condition in the vegetation is brought about. It has already been shown that the vegetation of a ridge peak (see p. 641) in the *Dipterocarpus-Shorea* formation is partially dwarfed, and for Mariveles Mountain this tendency reaches its climax in one to be discussed below and designated as the *Eugenia-Vaccinium*, but in comparison with the latter it is much less pronounced in the formation under discussion. At an altitude of 760 meters there appears an exposed ridge peak which has a thin soil and a strikingly xerophytic vegetation, which contrasts with the more protected one found in a slightly lower saddle near by. Here members of the *Dipterocarpaceæ* are entirely absent, although present in other situations at the same altitude within the formation. *Ternstroemia toquian*, *Thea montana*, *Quercus* sp., *Eugenia robertii*, and other species which are here encountered show a leaf surface much reduced from that which they present when they grow at an identical elevation in more favorable positions. The rutaceous *Acronychia laurifolia* with hard, and during the dry season, partially deciduous leaves, the rubiaceous *Tricalysia* sp., and the melastomaceous *Memecylon affine*, both shrubby and with hard leaves, are among the common forms met with in similar physiographic situations at a greater altitude on the mountain. Mingled with the above may be found *Scolopia luzonensis*, *Atalantia disticha*, and *Buchanania florida*, all found in xerophytic positions in the *Anisoptera-Strombosia* formation. *Buchanania* is especially marked by its very much reduced leaves. (Pl. XLIII, A). *Sterculia montana* is the only tree noted which for

a few days during the dry season was completely deciduous. Another plot, on a level bench of the main ridge at the same altitude and in the same physiographic situation as that of A, Table XIX, has a much more xerophytic and open vegetation than it would be expected to have, the difference apparently being caused by its greater exposure to the wind. Again, on a slope of 25° on the main ridge a vegetation exists which reminds one very much of that of the *Dinochloa parang* of the lower altitudes. Here *Dinochloa tjankorreh* is found growing together with species of *Calamus*, other procumbent lianas, and small trees such as *Casearia solida*, *Dysoxylon turczinanowii* and others. Plot B, Table XIX, has the same slope and depth of soil and although at the same altitude, is much less exposed. Plot C, Table XX, compares very favorably with Plot B, Table XIX, in all particulars excepting that the former is much more subject to the sweep of the winds; as a consequence it has a less mesophytic vegetation and members of the *Dipterocarpaceæ* are almost absent. In Plot C, Table XX, *Anisoptera vidaliana* reaches its highest altitude noted on the Reserve. The examples which have been cited will suffice to show that mere *exposure* has a tendency to make a less mesophytic and a more open vegetation irrespective of soil conditions. Other things being equal, the steeper the slope the more unstable and shallow will be the soil and as a consequence the greater the paucity of arborescent growth. A comparison of the plots analyzed in Table XIX emphasizes this fact. In this instance the situations of the plots are approximately the same in regard to exposure and altitude, but the slopes vary in degree from a level ridge-bench to those having an inclination of from 25° to over 45°. In those up to 40°, the members of the *Dipterocarpaceæ* together with other trees of the same crown class maintain the ascendency with the associated shade species. In slopes of over 40°, these trees become of less importance and when they do exist they seldom have developed beyond the sapling stage. They are associated with smaller and, during the dry season at least, less mesophytic or light-loving tree species, such as *Casearia solida*, *Buchanania florida*, *Semecarpus perrotettii*, *Itea macrophylla*, and others, all of which are nearly absent where the slope is less steep. *Crypteronia cumingiana* reaches its best development on the edges of overhanging cliffs and probably because of a deep and wide spreading root system it is peculiarly fitted to maintain a foothold on unstable soil, although this tree is not found in places where the exposure to wind is great. (Pl. XXIX.) Precipitous slopes having an inclination of over 45°, contain but little arborescent vegetation; they usually form the sides of box canyons and are consequently more or less protected from drying influences of direct insolation. Ridges such as have been described, alternate with deep ravines the sides of which may be sufficiently steep to be classed as gorges. The slopes of the former are sparsely covered with forests and even when they are steeper than 50°,

may have shelves which contain trees the presence of which prevents more rapid erosion; the latter if unobstructed would render the slope so unstable as to become entirely treeless. The rocky, dry bed of these ravines is almost destitute of soil and correspondingly arboreal vegetation is entirely absent. Indeed, save for a scanty growth of ferns and mosses, vegetation of all kinds is wanting, although lichens are abundant on the rocks. A number of causes combine to bring about this condition. The lack of sufficient soil alone would operate against the invasion of plants from the slopes; during the dry season strong insolation increases the xerophytic condition of the habitat, and in the rainy season the torrents which periodically sweep through the bed of the ravine make the situation an exceedingly unstable one. However, small side ravines opening into the larger ones give a habitat of sufficient stability to support a rich vegetation. (See Pl. XXX.)

Nearly perpendicular eroding banks of the Lamao and other rivers show distinct types. If, as often is the case, these banks are exposed to strong insolation from one side, the vegetation during the dry season is confined to the small trees such as *Casearia solida*, *Brucea luzoniensis*, *Villebrunea trinervis*, *Leucosyke capitellata*, and the ferns, *Polystichum coniifolium*, *Polybotrya appendiculata*, *Asplenium laserpitiifolium*, and others. Other herbaceous plants are scattered specimens of *Begonia rhombicarpa* and species of *Selaginella*. During the rainy season these become represented by a greater number of specimens; indeed, in the more stable places on these walls, species of *Selaginella* and *Begonia* form more or less dense growths. In every instance where such banks are moistened by the seepage of underground water, the habitat is favorable for the development of mesophytic vegetation which is only slightly less luxuriant during the dry season. It is noteworthy that the vegetation occupying such habitats is ecologically remarkably uniform from the base to the top of the mountain. Plates XXXI and XXXII show two such situations at different altitudes, one in the *Anisoptera-Strombosia*, the other in the *Shorea-Plectronia* formation. The araceous *Schizmatoglottis rupestris* and *Begonia rhombicarpa* are common to both situations. Plate XXXIII shows two banks of the Lamao River at 500 meters' altitude; on the left there is no seepage and consequently but little vegetation excepting lichens; on the right there is seepage, with a resulting luxuriant growth of *Schizmatoglottis* and the urticaceous *Elatostema whitfordii*. The boulders in the river bed of the larger streams (see Pl. XXXIII) are entirely destitute of anything except crustaceous lichens and occasionally the fern, *Gymnopteris inconstans*. This latter with the creeping rubiaceous *Geophila herbacea*, *Trichomanes javanicum*, and a species of *Selaginella* constitute the vegetation of the wet rocks of the small but persistent streams, or in situations where the seepage is sufficient to maintain a wet atmosphere as well as a wet soil during the entire year. On the walls of narrow

box gorges, where seepage is constant during the dry season and where the insolation is low, delicate shade or mesophytic plants, usually ferns, are found. Here the tree fern, *Alsophila contaminans* is present and the very delicate *Lindsaya concinna* forms thick growths with *Microlepia pinnata*, *Nephrodium cuspidatum; Schizmatoglottis, Geophila*, and *Gymnopteris*, already mentioned as occurring in similar ecological situations, are also present. Two liverworts, *Anthoceros grandis* and one undetermined species of this group, are the only ones noted here. The temporarily less mesophytic conditions, due to steepness of the slopes or to exposure, or to both, and the temporary climax mesophytic vegetation due to unstableness of topography, dampness of soil, and low saturation deficit cited above are sufficient to show differences due to topographic situation.

The formation is almost devoid of level stretches which at the same time are not exposed. However, gentle slopes are present and where they are not near to the edge of ridges, they exhibit vegetative appearances as nearly akin to the stable climax condition as the climate is able to support. Such slopes are encountered in the small cirque-like basins situated at the heads of small streams, or still better on the south side of the Lamao, near the head waters of the Camayauan and Alangan rivers. It is here that the *Dipterocarpaceæ*, especially *Shorea polysperma*, *S. contorta*, and *Hopea acuminata*, reach their best development. Prominent, and reaching its largest dimensions (200 centimeters in diameter), is *Agathis philippinensis*, and, here also, the best growth of *Plectronia viridis*, *Podocarpus blumei*, and other associates of the second-story vegetation is encountered.

The epiphytic vegetation, corresponding with the more favorable climatic conditions, is more abundant in contrast with the formations lower down. The most conspicuous of the epiphytes is the bird's-nest fern, *Asplenium nidus*. (See Pl. XXXIII.) This is present in protected places, such as parts of the forest well back from the ridges, and on trees and rocks in the canyons of the Lamao River and its tributaries. The rubiaceous ant plant, *Myrmecodia echinata*, is also present on the limbs of the tall trees. Several undetermined orchids and the ferns *Davallia solida*, *Vittaria lineata*, *Anthrophyum reticulatum*, and *Polypodium meyenianum* are encountered, these species being more abundant in the gorges near the stream than they are on the ridges, but nearly all of these, as will be shown below, reach their best development at higher altitudes.

Summary.—1. In contrast with the lower formations, that of the *Shorea-Plectronia* shows a climate conducive to a more mesophytic vegetation. (See climatic data for Station 3, which is in this formation.)

2. Corresponding to these conditions the vegetation, as a whole, shows a less tropophytic character than that in the lower formations.

3. However, physiographic situations show a marked variety in the

nature of the vegetation. On exposed ridges and steep, exposed slopes it is decidedly less mesophytic and more tropophytic, although it is rare to find trees entirely without leaves. Box cañons and springy, protected slopes show delicate mesophytic plants.

4. Because of the unstability of the topography, the luxuriance of the vegetation is not as great as that which, were the physiography more stable, the climate would lead one to expect.

V. THE EUGENIA-VACCINIUM FORMATION.

This formation includes that portion of the mountain lying above the 900-meter contour line.

Climate.—Its climate is distinguished from that existing below by two distinct features which, so far as plant life is concerned, are antagonistic to each other. These are *strong winds* and a *much higher relative humidity.* The former give rise to the peculiar, dwarfed condition of the tree growth, the latter to the abundance of epiphytic vegetation. The influence of strong winds on the arborescent vegetation on the rim of the crater and on the main ridges leading to it is especially well marked. Here, under these conditions of exposure, the vegetation receives the full effect both of the northeast monsoon blowing across Manila Bay and of the southwest one from the China Sea. A more detailed account of the effect of these winds will be given after the vegetation of the mountain top has been considered.

The fact that the relative humidity is higher in this situation, is made evident by the frequent fogs which at night, as a general rule, hang over the top of the mountain. The following readings, taken on clear days, were made simultaneously at Station 3 and at various altitudes on the main ridge:

TABLE XXI.—*Relative humidity at different altitudes on Mount Mariveles.*

1905	Hour	Altitude. 640 meters	914 meters.	1,060 meters.	1,250 meters.
Mar. 23	9.00 a. m.	91	98		
	12.30 p. m.	77			
Mar. 24	7.30 a. m.	81	80		
	12.30 p. m.	75	85		
Mar. 29	8.30 a. m.	77	82		
	3.10 p. m.	[illegible]	54		
Mar. 31	8.00 a. m.	75	82		
	3.00 p. m.	62	60		
Apr. 5	8.20 a. m.	74		81	
	9.20 a. m.	75			89
Apr. 6	2.30 p. m.			76	
	1.30 p. m.	91			
Apr. 7	9.00 a. m.	77		78	
	10.00 a. m.	76		85	
Apr. 21	8.30 a. m.	94		82	
	9.30 a. m.	86			83
Average of 8 readings		73.6	77.6		
Average of 5 readings		82.4		80.4	
Average of 2 readings		80.5			86

These readings, although few in number, clearly indicate a higher relative humidity for the altitudes above 900 meters. This bears out the observations which have repeatedly been made that the stations above 900 meters were often in mist, whereas those below were not. The following temperature readings were made simultaneously at different altitudes:

TABLE XXII.—*Temperature at different altitudes on Mount Mariveles.*

1905	Hour.	Altitude. 640 meters.	914 meters.	1,066 meters.	1,250 meters.
Mar. 23	9.00 a. m.	21.2	19.2		
	12.30 p. m.	24.2	21.1		
Mar. 24	7.30 a. m.	20.2	18.5		
	12.30 p. m.	24.8	20.6		
Mar. 29	8.30 a. m.	23.8	21.4		
	3.10 p. m.	26.5	25.5		
Mar. 31	8.00 a. m.	24.5	21.5		
	3.00 p. m.	26.5	25.4		
Apr. 5	8.20 a. m.	23		20.2	
	9.20 a. m.	23.2			19.6
Apr. 6	1.30 p. m.			21.6	
	2.30 p. m.				
Apr. 7	9.00 a. m.			20.6	
	10.00 a. m.	25	------	21.4	--
Apr. 21	8.30 a. m.	23.5	-	21.5	
	9.30 a. m.	21.5	----		21
Average of 8 readings		24	21.7		----
Average of 5 readings		23.1	-----	21.1	-------
Average of 2 readings		23.8		----	20.5

Unfortunately, no readings were obtained for the early morning hours during January or February, so that the minimum temperature on the mountain can not be ascertained. The lowest reading for February at Station 3 (640 meters) is 17°.8 C. The greatest difference in temperature observed between the station at 640 and that at 1,250 meters is 3°.6. If this same ratio had obtained when the reading 17°.8 C. was taken at the 640-meter station, then the temperature would have been 14°.2 C. at 1,250 meters. To judge from the above calculation it is probable that the temperature of the top of the mountain does not fall much, if any, below 14°, and it should be noted that this is far above the danger point for tropical plants, because Molisch[47] has shown that members of the *Gesneriaceæ*, which belong in this class, died only when a temperature of between 2°.5 C. and 4°.4 C. was reached. The margin between 14° C. and 4°.4 C. is certainly a wide one and even though it be true that the temperature on the top of the mountain *may* fall below 14° while the minimum for the existence of tropical

[47] Molisch, H.: Das Erfrieren von Pflanzen bei Temperaturen über dem Eispunkt. *Sitzungber. Akad. Wiss.*, Vienna (1896), **105**, part 1, 82 to 95.

plants is higher than 4°.4 C., yet it is not probable that the plants of the lowlands are excluded from the top because of low temperature alone.

The topography.—The topography is such as to offer no very stable place for vegetation to gain a foothold. It consists of the knife-like ridges, which seem to be characteristic of tropical, volcanic mountains in a youthful stage of erosion, and precipitous slopes leading to the principal streams which lie at the bottom of the cañons separating these slopes. The latter, in turn, are cut up into steep ridges and side cañons, the inclination of both of which in places may be very precipitous. The side cañons such as are found near the headwaters of the Lamao River, during the rainy season, present waterfalls and cascades, and the side ridges usually end in the precipitous walls of the Lamao River canyon. (Pls. I and II.)

In contrast with the topography of lower altitudes, that of the top of the mountain presents narrower main ridges and steeper side ridges and canyons.

The ridge vegetation.—Eight plots were made, each one corresponding to a definite physiographic outline on the main south ridge leading from a peak ridge at 900 meters' altitude to Buena Vista peak (altitude 1,266 meters) on the rim of the crater, a distance of about 6 kilometers. These plots were undertaken with the purpose of determining the nature of the vegetation in this situation and of discovering, if possible, what factors, climatic and edaphic, determine the differences.

Description of Table XVIII.

A is a plot approximately 8 by 45 meters at 900 meters extending through an altitudinal range of 3 to 4 meters. It is an exposed peak, with soil composed of clay, some loose rock, and a half-disintegrated outcrop of volcanic rock B is a plot 6 by 37.5 meters at 900 meters' altitude on top of a hard, volcanic rock with little soil. It is an exposed peak. C is a plot 5 by 30 meters at 914 meters' altitude on a level ridge, not as exposed as A or B. The soil is a heavy clay, with some loose rock, although it presents no outcrop. Plot D is irregular in shape, comprising about 175 square meters on an exposed cliff which shows a volcanic outcrop of rock, with a little shallow soil in places (altitude 1,034 meters). Plot E has an area of 7 by 45 meters on a level stretch, at 1,034 meters in altitude. The soil is composed of deep clay, with large bowlders which have withstood weathering processes. F is a plot of 4 by 48 meters, on a bluff similar to that of Plot D, but with slightly more soil (altitude 1,100 meters). G is a plot of 4 by 50 meters at an altitude of 1,135 meters on a level ridge which has a fair amount of clay soil, although semidisintegrated rock is near the surface. Plot H with an area of 5 by 35 meters is at an altitude of 1,265 meters (Buena Vista peak). The soil characteristics are similar to these encountered in Plot A, but the exposure is greater. I is the total of each species in all plots; J, the percentage of each species in all plots. No trees under 3 meters are included and none reached a height of over 15 meters.

TABLE XXIII

	Name of plant	A	B	C	D	E	F	G	H	I	J
1	Eugenia congesta				1	5	8	30	25	64	9.18
2	Eugenia acuminatissima	12	4	17	4					57	7.16
3	Acronychia laurifolia		12		29					41	5.87
4	Quercus sp.	11		2	8	[illegible]	6	7	2	40	5.74
5	Vaccinium cumingianum				15	1	[illegible]	4	[illegible]	33	4.73
6	Clethra lancifolia					[illegible]	9	8	[illegible]	28	4.01
7	Vaccinium jagori						10	4	14	28	4.01
8	Leptospermum amboinense				11		8		5	24	3.44
9	Myrica rubra	7				1	8	4	3	23	3.29
10	Symplocos confusa						2	9	11	22	3.15
11	Eleutima luzonensis				5			1	8	19	2.72
12	Decaspermum blancoi		16							16	2.29
13	Decaspermum paniculatum		4		9		3			16	2.29
14	Sideroxylon angustifolium				3	8	1	4		16	2.29
15	Ternstroemia toquian	4		10		2				16	2.29
16	Alstonia parvifolia						5	8		13	1.86
17	Eurya acuminata				4	1	4		3	12	1.72
18	Ligustrum cumingianum		6		5					11	1.58
19	Linociera coriacea	11								11	1.58
20	Polyosma philippinensis	1		4		4			2	11	1.58
21	Adinandra luzonica							10		10	1.43
22	Buchanania florida		[illegible]							10	1.43
23	Evodia retusa						5	5		10	1.43
24	Helicia philippinensis				10					10	1.43
25	Casearia crenata		3		6					9	1.29
26	Excoecaria philippinensis	9								9	1.29
27	Scolopia crenata	1	8							9	1.29
28	Astronia rolfei	1				4		3		8	1.15
29	Agathis philippinensis	1		4	1		1			7	1.00
30	Engelhardtia subsimplicifolia	1			2		1	3		7	1.00
31	Eriobotrya ambigua		1		5	1				7	1.00
32	Helicia cumingiana					4		3		7	1.00
33	Leucosyke capitellata var. celtidifolia		7							7	1.00

TABLE XXIII—Continued.

Name of plant	A.	B.	C.	D.		F.	G.	H.	I.	J.
34. Antidesma sp	6								6	0.86
35. Machilus philippinensis					2					.86
36. Eugenia sp			1		4				5	.72
37. Ficus sp									5	.72
38. Glochidion sp								1	5	.72
39. Allophylus sp		4							4	.57
40. Canarium villosum									4	.57
41. Pithecolobium prainii										
42. Symplocos ahernii									4	.57
43. Viburnum odoratissimum	4								4	.57
44. Weinmannia luzoniensis						3		1	4	.57
45. Ficus bataanensis				1	1	1			3	.43
46. Linociera luzonica					3				3	.43
47. Mastixia pentandra			1						3	.43
48. Calophyllum whitfordii			1						2	.29
49. Gynotrochis parvifolia									2	.29
50. Talauma villariana									2	.29
51. Sp. indet									2	.29
52. Cryptocarya luzoniensis									1	.14
53. Eugenia robertii			1						1	.14
54. Ficus sp	1								1	.14
55. Fagraea obovata		1							1	.14
56. Linociera luzonica		1							1	.14
57. Murraya exotica				1					1	.14
58. Nauclea purpurea			1						1	.14
59. Palaquium sp									1	.14
60. Plectronia viridis	1									
61. Rubiaceae sp				1					1	.14
62. Sterculia montana		1							1	.14
63. Symplocos ferruginea	1								1	.14
64. Mischocarpus triqueter	1								1	.14
65. Vernonia arborea									1	.14
Total	108	75	46	129	60	90	97		698	100.00

Some striking contrasts and resemblances are shown in a comparison of these plots. Of the 21 species found in Plot A (see Pl. XXXIV) and the 15 found in Plot H (see Pl. I), only 3 are common to both; one of these, *Polyosma philippinensis,* is represented by 3 individuals; the second, *Myrica rubra,* by 10 individuals, and the third, *Quercus,* by 11 in A and 2 in H; however, this latter may represent two species. To what then is this difference in vegetation due? It can not alone, if at all, be ascribed to a lower temperature, for this factor is but a small one. The depth and character of the soil are approximately the same, for both plots have shallow soil composed principally of half-disintegrated volcanic rock. Precipitous slopes on each of the sides of the ridges characterize both situations. The difference can not then be due to the water-holding capacity of the soil, for if anything, as will be shown presently, the soil in the higher situation has more water than that in the lower, yet the tree vegetation in the former is more xerophytic than in the latter—that is, the trees are more stunted and the leaves are harder, smaller, and more leathery. This point is clearly demonstrated in the species common to both situations: the oaks invariably have smaller and harder leaves; a specimen of *Calophyllum whitfordii,* collected from a stunted tree near Plot A, at first gave rise to the belief that this was a species distinct from that found at lower and more protected altitudes in the *Shorea-Plectronia* formation, but when fertile specimens were collected in Plot H from a still more stunted tree and with still more reduced and hardened leaves, the series was complete, extending from the comparatively mesophytic leaves taken from tall trees in the *Shorea-Plectronia* formation, through the less mesophytic forms found near Plot A, to the xerophytic leaves of that found on H. (See Pls. XLIII, XLIV, XLV.) The same may be said of other species, such as *Myrica rubra,* common to the three situations. (See Pl. XLIV.) These gradations can be extended so as to include many species not common to the two plots under consideration, but found in different ecological conditions from the base to the summit of the mountain and which systematists are tempted to, and often do, separate as distinct species, if ecological gradations between the two extremes are not in their possession. (See Pls. XLIII, XLIV, XLV.) These cases only illustrate the fact which has been so often emphasized for plants occurring in the temperate zone, that species capable of sufficient plasticity can adapt themselves to conditions in such a manner as to grow in various ecological situations. But few have this power of wide life-range, and so it happens that different ecological aspects show different species, rather than different forms of the same one. This latter fact is strikingly illustrated by the largest number of individuals on the ridge under consideration. (See Pl. XLV.) *Eugenia congesta* found in the upper five plots has orbicular, very leathery leaves, while *Eugenia acuminatissima,* in the lower four plots, has small,

narrow ones of less xerophytic structure. Only in Plot D does the distribution of these species overlap. Other trees with very xerophytic leaves, found in the upper plots and not represented in the lower ones, are *Vaccinium jagori*, *V. cumingianum*, *Leptospermum amboinense*, and *Clethra lancifolia*, all low, scraggy trees with leaves very suggestive of those of the *heath* family to which two of them belong. Indeed, ecologically the forest of the ridge very much resembles the *heath* associations so common in dry, sandy soils or exposed windy places of the north temperate zone, except that here the plants are trees rather than shrubs.

There is a striking difference in the relative humidity of the two situations. (See Table XXI.) Many visits to Plot A, when the weather was clear at this locality, showed Plot H to be bathed in dense fog. Often, an early morning journey from Station 3 to the top of the mountain demonstrated Plots A and D to be dry while above Plot D the vegetation would gradually become more and more wet, until near Plot H it would be reeking with moisture. While this relative humidity in itself tends to reduce the transpiration of the foliage of the trees and to conserve the moisture of the soil, so as to render more water available for absorption and thus to produce a less xerophytic condition, yet it is seen that the tree vegetation is more, rather than less, xerophytic. If, then, soil, moisture, and atmospheric humidity can not explain the ecological difference in the habitat for arboreal vegetation of the two places, then it must be due to the greater influence of the wind in the two situations. As one ascends the mountain, this becomes more and more pronounced, the trunks of trees become shorter (see Pl. XXXIV), until in many places near the top of the highest peaks the trail becomes a tunnel the top of which, composed of mingling branches of the trees, is so low that one often has to stoop in order to pass through it. The branches, also, in many cases, become more scraggy and crooked and the twigs shorter and stouter. Again, especially in the case of *Leptospermum amboinense* (see Pl. I), the branches have an arrangement in one or more stiff, horizontal planes and known as the umbrella type, which, according to Schimper,[48] is an adaptation calculated to resist the strong winds. This tree is invariably found on the most exposed places, where the erosion is sufficiently rapid to keep the bed rock at or near the surface. Its leaves are so reduced in size and so hard as to become almost like coniferous ones in form and texture. On the whole, the effect of exposure on the arboreal vegetation on the ridge under consideration is such as to obtain here, so far as stunted growth and reduction in leaf size is concerned, the most xerophytic condition on the Reserve, not excepting the extremely xerophytic vegetation of the sea beach cliffs and the mangrove swamps, and this condition is brought about notwithstanding the fact

[48] Schimper, A. F. W.: *Pflanzengeographie auf physiologischer Grundlage* (1898), English edition, translated by Fischer (1903), 348.

that, on the whole, the relative humidity and the rainfall are greater and the average temperature is lower, all factors which are favorable to mesophytic vegetation.

In the above discussion, two areas presenting approximately the same soil conditions have been compared. It now is in order to discuss situations in which the altitude and exposure are the same, but in which the soil conditions differ. In this respect Plots A and B offer admirable examples. The former has already been described. Plot B is separated from it by a ridge-saddle only. It is a large rock (Pl. XXXV) on three sides standing 1 to 6 meters above the ridge on which it is situated, on the fourth grading more perceptibly into the ridge itself, although here also it rises slightly above it. The upper surface is covered with a very thin soil most of which owes its origin to vegetable decay. On this rock the arboreal vegetation has established itself only because its fissures offer opportunity for the former to maintain a foothold. Both the dwarfed condition and leaf surface of the trees which are present show this situation to be a more xerophytic one than that of Plot A. The species are almost entirely different. *Eugenia acuminatissima*, represented by 32 individuals on Plot A, here has only four and these are at the end of the rock where the soil is deepest. *Acronychia laurifolia*, *Decaspermum blancoi*, *D. paniculatum*, *Ligustrum cumingianum*, *Leucosyke capitellata* var. *celtidifolia*, found in Plot B, are not represented in Plot A, although nearly all of them occupy places in a similar situation in Plot D, which is on a rock cliff distant some 2 kilometers, at an altitude 150 meters higher. *Acronychia laurifolia* and *Decasperum paniculatum* are good illustrations of the deciduous habit in trees on the mountain and emphasize the xerophytic nature of the ridge habitat. Both these trees, like the other species, have hard, xerophytic leaves. During the latter portion of March and first part of April they are almost destitute of foliage. The leaves of *Acronychia*, before they are shed, fold or half shut on the midrib, thus considerably reducing the transpiring surface. Many other trees also show a more diminished leaf display during a portion of the dry season than they do during the rainy one. Indeed, almost without exception, as is true of the formation at the base and in more xerophytic situations on the higher slopes, there is an interval of time between the beginning of the shedding of the old leaves and the appearance of the new ones. This, in the aggregate, makes the forest canopy much thinner during the dry months and is undoubtedly an adaptation to prevent rapid transpiration.

On ascending from the slopes of the *Shorea-Plectronia* formation to the first prominent ridge peaks, one finds a very sudden transformation from the tall trees to the dwarfish arboreal growth of the ridge (see Pl. XXXIV and contrast it with Pl. XXII), and apparently in conformity with this change there is a still greater variation in the multiplicity of the species and the individuals of the epiphytic vegetation. This

change appears to be remarkably abrupt, because the lower trees render the plants more visible to the casual observer, but in reality it is not so great as at first it would seem to be. It has already been noted that toward the upper limits of and in more favorable situations in the *Shorea-Plectronia* formation, there is a tolerably rich display of epiphytes, which in the more closed places of the forest are confined to the large limbs of the tallest trees, because the shade of the latter is so dense as to exclude plants accustomed to places having more light. However, as the higher and more exposed altitudes are reached and trees become lower, epiphytic vegetation, represented by mosses, a few liverworts, and an occasional orchid or fern, is found not only on the limbs but also on the trunks of the trees, so that, advancing from Plots A to H there is a gradual increase in richness of the epiphytes. This increase is in direct correspondence with the rise in the humidity. As has already been mentioned, the region near the top of the mountain is more often enveloped in a dense fog than are the other parts and to this difference in humidity the wealth of epiphytes can be ascribed. It is a well-known fact that plants, especially orchids, which depend on the moisture of the atmosphere for the water which they absorb, are not capable of condensing the vapor present therein but on the contrary, must have condensed water for their needs—that is, the moisture must be accessible to them in the form of rain or mist. In plants with absorbing organs adapted to take up moisture from the air, and exposed alternatingly to a very moist and a very dry atmosphere, xerophytic adaptations are necessary.

For the purposes of this paper, the epiphytic vegetation of Mount Mariveles may be divided into three groups, viz, (1) plants with xerophytic, photosynthetic organs and special adaptation for absorbing moisture; (2) those with mesophytic leaves which, by assuming the so-called resurrection form, can withstand loss of moisture and (3) the forms with xerophytic leaves and with no special adaptations for absorbing moisture. The lichens and orchids belong to the first group, and these are classed together because the velamen of the orchid roots, in times of drought and excessive moisture, behaves in the same manner as does the fungus element of lichens. On the trunks of the trees situated at the mountain top but few lichens are found, because these more favorable situations are quickly occupied by other less humble epiphytes; as a result the lichens are confined to the faces of newly broken rocks whereas the older ones are as densely covered with mosses, liverworts, and ferns as are the trunks of the trees.[49] The trees of the lower altitudes, with trunks the bark of which is smooth and not frequently shed, are often so thickly covered with crustaceous species of lichens as to render it almost out of the

[49] Strictly speaking, of course plants growing on rocks are lithophytes. Ecologically they are like epiphytes and are here classified as such.

question to determine the original color of the bark. A number of gray *Cladonia* and *Usnea*-like lichens are found on the branches of the trees growing at higher altitudes, intermingled with the greener mosses and liverworts. These may be seen hanging in festoons or as upright, fruticose forms. However, in this situation the lichen vegetation is comparatively insignificant. The orchid epiphytes, on the other hand, are very rich in species and some of the latter are represented by many individuals. Varied forms are exhibited. The most common one encountered above the 1,000-meter line is the grass-like *Acoridium tenellum* (see Pl. XXXVI) and other species of *Acoridium* simulate the latter but not so successfully. Species having exceedingly fleshy leaves are very abundant, some forms with and some without their leaf bases swollen into bulbs; others have creeping rootstalks embedded in the other epiphytic vegetation. When this is the case, the velamen may be poorly developed or be wanting altogether. Most humble is the small *Taeniophyllum obtusum*, with no leaves at all but with roots which act as photosynthetic organs. In this respect the arrangement of its chlorophyll and protective (velamen) tissue is exactly like that in the fruticose lichens, excepting that the side of the root next the substratum has no chlorophyll. Some idea of the richness of the orchids in species can be given by the following list: *Corysanthes merrilli Coelogyne sparsa, Pholidata imbricata, Platyclinis glumacea, P. latifolia, Acoridium tenellum, A. whitfordii Cestichis philippinensis, C. merrilli, C. compressa, Ceratostylis philippinensis Dendrobium macraei, Eria graciliscaposa, Phreatia luzonienses, Bulbophyllum bataanensis, B. cuneatum, B. dasypetalum B. lasioglossum, B. whitfordii*, and a large number of species not yet determined. (See Pls. XXXVII and XXXVIII.) The fact that, so far as the ridge is concerned, there is scarcely a full-grown tree to be found above the altitude of 1,000 meters which has not twenty or more specimens on it, will show the abundance of individuals.

The second group of epiphytes is represented by mosses, leafy liverworts, and the so-called "filmy" ferns (*Trichomanes* and *Hymenophyllum*). All of these are plants having very delicate, mesophytic leaves which, because of their texture, have the capacity of directly absorbing moisture, and which, during the hotter and drier parts of the day, lose water to such an extent as to wither and curl up. (See Pl. XXXVIII.) They remain in this condition until the relative humidity of the atmosphere increases to a sufficient extent to enable them to recover their rigidity. These "resurrection" plants increase in abundance of species and individuals with the rise in the frequency of fog and relative humidity. Strictly speaking, the plants last mentioned, like the orchids, can not be classed as epiphytes alone, for they may grow on old logs and rocks. At the base of the mountain, comparatively speaking, there is a poor expression of moss, fern, and liverwort vegetation. Here they either occupy positions at the bases of the trees,

as is the case with the moss *Taxithelium instratum*, or on bowlders in the streams where the mosses *Fissidens zollingeri*, *F. zippelianus*, and *Ectropothecium* and others are found. In the low-altitudes, filmy ferns of the genus *Trichomanes* are encountered only on shady, damp rocks at the edges of the streams; however, as one ascends their beds, the rocks become more and more covered with mosses; but in such situations, because of the swift currents in times of high water, the type is poorly represented. On the whole, the infrequency of these plants in the lowlands and indeed below the *Eugenia-Vaccinium* formation, is a noteworthy fact and is in direct response to the dry conditions during a portion of the year which favor what for convenience may be called *annual* rather than *daily* tropophytes. In the ridge under consideration, and below 1,000 meters, the filmy fern vegetation is scanty and it appears only in the shade; above this altitude it becomes abundant and it then increases with the elevation, however being always more abundant in the shady rather than in the sunny spots. *Hymenophyllum multifidum*, *H. smithii*, *Trichomanes pallidum*, *T. bipunctatum*, and others are among the species present. (See Pl. XXXVIII.) On the other hand, the liverworts and mosses are prominent features between Plots A and D, although they are much more so from F to H. Indeed, in these latter places, trees are covered with these plants from the bases of their trunks to the ends of their twigs, where the leaves are usually grouped. On rocks, fallen trees or limbs, and in every place in the shade where the wash from the heavy rains does not prevent their occurrence, dense masses, which give such an aspect to the vegetation called the "mossy forest," accumulate. Plates XXXVI, XXXVII, and XXXVIII show the richness of this forest in these epiphytes, and the list of mosses and liverworts given below indicate the number of species which occur although, no doubt, only a small percentage of the total number has been collected: *Hepaticeæ: Brazzania erosa*, *B. praerupta*, *Lepidoza trichodes*, *Mastigophora diclados*, *Schistochila aligera*, *Frullania integristipula*, and *F. orientalis*. *Musci: Dicranoloma blumei*, *Leucobryum sanctum*, *L. javense*, *L. angustifolium*, *Macromitrium cuspidatum*, *M. reinwardtii*, *Rhizogonium spiniforme*, *Spiridens reinwardtii*, *Aerobryum lanosum*, and *Sematophyllum altopungens*.

The third group of epiphytes is largely composed of ferns.[50] Many of these are facultative epiphytes and frequently the moss and liverworts furnish a substratum for them. Since this substratum is alternately dry and wet, the response to the severe conditions is found in their

[50] Dr. E. B. Copeland, who is writing on the comparative ecology of the Philippine ferns, informs me that epiphytic ferns which are not embedded in moss usually have their roots covered with a felty mass of persistent root hairs, and that these are often absent when the roots are so embedded. Such ferns would then have special absorptive organs and would be classified with the orchids and liverworts.

xerophytic, sometimes partially tropophytic, leaves. *Humata repens* (see Pl. XXXVIII) is probably most common. It has a small, creeping rhizome, usually buried in the bed of moss and other plants with which it grows. *Polypodium glaucum*, *P. palmatum*, *P. triquetum*, *P. accendens*, and others are similar to it in habit. *Davallia solida* and *Oleandra colubrina* also have this creeping habit. The latter has connection with the ground, and it sometimes reaches the tops of stunted trees; its mottled, snake-like stem often not being buried in the living substratum. Prominent because of its size and abundance, is the bird's-nest fern, *Asplenium nidus*. (Pl. XXXIX.) It usually starts in a crotch of a tree, where some vegetable débris has already accumulated; or in a knot hole, in which case it may encircle the entire trunk if the latter is not too large; once established, the "nest" part of the fern accumulates an amount of soil sufficient to bury its roots. The substratum so provided furnishes a favorable habitat for other ferns, so that scarcely a specimen of the bird's-nest fern was noted which did not also have present the long, pendant fronds of *Polypodium subauriculatum*. The strap-like leaves of *Ophioglossum pendulum* are present with much less frequency. The living substratum, together with the accumulated decaying vegetable matter and inorganic débris may in places be so dense that shrubs like *Rhododendron quadrasianium* and *Medinilla ramiflora* may start and live throughout their entire existence on the branches of trees. Seedlings of trees such as *Eugenia congesta* may also be present on branches of their own kind. (See Pl. XXXIX.) The bulbous base of the ant fern, *Lecanopteris carnosa*, besides harboring insects, acts as a storehouse for moisture.

The vegetation, other than that of trees and epiphytes, also varies with the plot, but those plots which are alike in physiography and atmospheric moisture show a remarkable similarity. In situations which are too poor or unstable to support tree vegetation, and which are not shaded by overhanging cliffs, the grasses *Garnotia stricta* and *Miscanthus japonicus* and the sedge *Carex continua* predominate. This is the case in places in or near plots B, D, F, and H. Terrestrial ferns are represented by a large number of individuals during the wet but are less noticeable during a portion of the dry season. Among these may be mentioned *Dipteris conjugata* which, in open places at the head of land slips, forms colonies very much resembling those of the may-apple (*Podophyllum peltatum*) so common in the eastern part of the United States. In similar situations also thickets, 1 to 2 meters in height, of *Dicranopteris* occur. On the ridge, dwarf specimens of the tree fern *Cyathea caudata* are scattered, and just below the top of the rim of the crater are a few individuals of *Marattia sambucina*.

The herbaceous seed plants which are partly or wholly wanting during a portion of the dry season are *Coleus multiflorus*, *Scutellaria luzonica*, an unknown saprophytic orchid, and very rarely *Arisaema polyphylla*.

Less herbaceous and with a portion of the leaves persistent is *Desmodium polycarpum ovalifolia*. Near the top especially on the slopes barely sufficiently stable to hold soil, are dense groves of the suffrutescent acanthaceous *Strobilanthus merrillii* and *S. pluriformis* with prop roots. These species have mesophytic leaves which are shed for a short time at least: the small green bracts of the inflorescence stalks, however, remain persistent and perform the function of the leaves. Among the erect and scandent shrubs are the following: *Chloranthus brachystachys, Discocalyx cybianthoides, Neslitsea zeylanica. Melastoma fusca, Memecylon affine, Medinella ramiflora, Pittosporum odoratum, Pandanus whitfordii, Thea montana, Viburnum sinuatum, Wickstroemia lanceolata, W. ovata,* and the following rubiaceous species: *Heydotis elmeri, Urophyllum bataanense, U. acuminatum. Psychotria bataanensis, P. diffusa, P. rubiginosa, Lasianthus bordenii. L. obliquinervis,* and *Amaracarpus pubescens.* It will be seen from the above list that the *Melastomaceæ* and *Rubiaceæ* are well represented in number of species. Two small palms, *Pinanga elmerii* and *P. barnesii* are found on the slopes, just beneath the top of the ridge, the former near all the plots and the latter at the higher altitudes. The liana vegetation is best represented by *Freycinetia ensifolia* which is on nearly every tree in the closed, mossy forests; *F. luzonica* is less frequently encountered. *Hiptage luzonica, Strongylodon macrobotrys, Dinochloa tjankorreh,* and a number of species of *Calamus* may be mentioned among the lianas. Shrubs and vines with showy flowers are represented by members of the *Melastomacea; Melastoma fusca* (shrub) and *Medinella coriacea* (vine) are present and their large, red flowers add color to the vegetation. The large, white, sweet-scented flowers of *Rhododendron vidalii* and *R. schadenbergii* appear profusely near the 1,100-meter contour line.

The pitcher plant, *Nepenthes alata*, is found in open places in this altitude and above. The sharp, knife-like rim of the crater (Pl. I) between Buenavista and Cabcaben peaks shows dense tangles of this plant, growing intermingled with shrubs and vines with here and there isolated patches of *Dicranopteris* and an occasional *Marattia*. Specimens of the *Schefflera blancoi* and *Pittosporum resiniferum* have the *balete* habit in capturing and strangling trees, although the latter from the beginning is a true liana and does not start as an epiphyte, as does the former. The upper portions of the main ridges leading to Cabcaben peak (outside the Reserve) and to Caybubo peak show conditions approximating the ones just described.

The vegetation of the slopes.—The slopes on either side of the Lamao River cañon (Pl. II) show some resemblances to and many differences from the ridge vegetation. The vegetation on the overhanging cliffs at the ends of the slopes leading to the canyons have much in unison with plots like D; for instance, the grass *Miscanthus japonicus* is common in this situation and the shrubby species of *Pittosporum odoratum* and *Acrony-*

chia laurifolia also predominate. The side ridges, as a general rule, consist of a series of short, steep inclines with talus slopes at their bases. The tree vegetation of the slopes consists of the taller and less xerophytic trees of the ridge, together with other species which probably are not able to exist on the more exposed places. Near these ridges the tree tops are covered with epiphytes, but these become much less common nearer the river bed, where the fog is less dense. In one plot the following trees were noted as being common: *Eugenia congesta*, *Eurya acuminata eupristа*, *Adinandra luzonica*, *Eugenia acuminatissima*, *Thea montana*, and *Clethra lancifolia;* these are intermingled with *Pygeum latifolium*, *Palaquium whitfordii*, *Eugenia bataanensis*, *Eugenia robertii*, *Agathis philippinensis*, *Semecarpus* sp., and others. In one place, nearly 75 per cent of the stand is the myrtaceous *Tristira decorticata*. This species is also common on and near the top of Limay peak, the vegetation of which is comparable with that of the side ridges of the Lamao River, having the same altitude, but the extreme summit of this peak itself has only a stunted growth. However, while the side ridges present a more mesophytic vegetation, as is evidenced by less stunted trees and the xerophytic leaves, the vegetation in this situation, owing to the unstable conditions, does not reach the luxuriance and the size which it would be expected to have as a result of the climate. It is perhaps because of this instability, that more fallen trees were noted in this region than on any other portion of mountain, although it is one of the surprising features of tropical mountain vegetation that very precipitous slopes, having a grade of from 45° to 60°, often are covered with a closed forest. Inclines of over 60° so often crumble that few trees have a chance to gain anything more than a temporary foothold thereon.

The side ravines near the headwaters of the Lamao River are very unstable. Where signs of ground water near the surface are in evidence, species of mosses, liverworts, and ferns are present in such situations, although the variety and the number of the individuals are much less than they are on the ridges. The very large-leaved fern *Dennstaedtia smithii* and the tree fern *Alsophila contaminans* are encountered here, the latter in the Lamao River cañon itself reaching to a height of 8 or 9 meters.

Cirque-like basins which are comparatively stable appear in many places near the upper ends of the side ravines. Groves of *Pandanus arayatensis* are encountered in these situations and here also the tree fern *Cyathea caudata* reaches its largest size, being from 2 to 3 meters in height, the large *Lycopodium*-like moss, *Spiridens reinwardtii*, usually growing upon it. The undergrowth is characterized by rubiaceous species and *Hydrangea lobbii*. The inside slopes of the crater are even more unstable than are those of the Lamao River cañon. Land slips are numerous, and comparatively, these sides show but a thin stand; yet when looked at from above, the closed forest seems to prevail. This is due to the fact that the foliage of the trees on either side nearly meet over the

narrow rocky gulleys and ravines. However, nearly perpendicular "scars" show a scanty growth of grass and of light-loving ferns. The vegetation on a "burn" at the head of one of these slides is worthy of mention because it shows the presence of a dense mat of *Funaria clavescens*, a species closely related to the *Funaria* which occupies similar situations in parts of the United States, and here, strangely enough, the cosmopolitan *Pteridium aquilinum* is also present. After a "slide" has occurred, the vegetal reclamation is rapid. In many places *Funaria calvescens* is the pioneer. The grasses *Miscanthus japonicus*, *Garnotia stricta*, the sedges *Hypolytrum latifolium* and *Carex continua*, and the ferns *Pteris tripartata* and *Pteridium aquilinum* are among the other species which may be mentioned as establishing an early foothold. These may be closely followed by acanthaceous and rubiaceous shrubs. In one place, *Rubus moluccanus*, *R. rosaefolius*, and *R. tagallus* were noted, while in addition, scattered specimens of the euphorbiaceous trees *Macaranga cumingii* and *Homalanthus populneus* are usually present, *Melastoma fusca* being also an early comer. As the stability of the slide increases, the composition finally partakes of the nature of the vegetation which is nearest to it.

Summary.— 1. The *Eugenia-Vaccinium* formation may be divided into two parts; the exposed ridges and their less exposed, unstable slopes.

2. The ridge vegetation is characterized by stunted trees, due to the influence of the wind, and by its richness in epiphytes, caused by the frequency of fogs.

3. The vegetation of the ridge is strongly suggestive of the "heaths" of the north temperate zone, excepting that heath-like trees replace the shrubby growth of the latter region; and orchids, filmy ferns, and liverworts are found in addition to the lichens and mosses.

4. The instability of the slopes prevents the best possible development of the vegetation which the climate (exclusive of wind) might support.

5. At the same altitude, different physiographic situations show a marked difference in the ecological character of the vegetation.

VI. Strand Formations.

The vegetation of the strand has been divided into two distinct types: that of the sandy seacoast lying above high tide, and that of the muddy shore situated between low and high tide. These two types, which are often adjacent, have an ecological similarity, but floristically they show a decided difference. Our knowledge of the composition and of the ecological adaptations of the strand vegetation is due in the main to Schimper [51] and Karsten.[52]

[51] Schimper, A. F. W.: *Loc. cit.*, 387–411, also, Die indo malayische Strandflora. *Bot-Mittgn. Trop.* (1891), 3.

[52] Karsten, G.: Ueber die Mangrove-Vegetation im Malayischen Archipelago. *Bib. Bot.* (1891), 22.

The 5 kilometers of coast line pertaining to the Lamao Reserve offers insufficient data for a true conception of the vegetation of the seashore of the Philippines, yet in this very situation a dilute expression of all the formations of the strand which have been made classic by the work of Schimper and others may be encountered. In order to render clear the genetic relations of these formations it is advisable to make use of data gathered outside of the area under consideration, and then to classify the stages in the development found at Lamao.

The material composing the beaches either is derived from rocky promontories or is washed into the sea by streams. If the shore current and waves are sufficiently strong to handle all this material then no accretion to the shore line takes place, but if, on the other hand, as is more often the case, the shore current can not bring this about, then an encroachment of the land on the sea results with a consequent development of new habitats for plants. If the shore current can not take care of the finer particles of the material eroded from cliffs or washed in by rivers, then obviously the heavier ones settle on the strand. Thus the size of the material composing the beach is determined by the power the current possesses of controlling the suspended matter carried by it, and, as a consequence, pebbly, sandy, or muddy shore lines may result. On some strands the very force which prevents the deposit of fine particles, excludes the growth of nearly all vegetation between the lines of low and high tide, so that, with the exception of scattered seaweeds, these places are destitute of vegetation. On the other hand, where the hydrodynamic conditions favor the deposit of materials lighter than sand, then they are also favorable for the establishment and growth of vegetation. In such places the characteristic formation not found anywhere outside of tropical countries is developed. Therefore, it will be seen that because of the physiographic forces at work along shores, two distinct habitats are established. Following Schimper, with some minor changes, the vegetation corresponding to these may be divided into –

1. Sandy beaches lying above high tide.
    - (*a*) *Pes-capra* formation.
    - (*b*) *Barringtonia-Pandanus* formation.
2. Strand, lying below high tide.
    - (*a*) Mangrove and *Nipa* formations behind sandy beaches.
    - (*b*) Mangrove and *Nipa* formations not behind sandy beaches.
        - *α*. Formations at the mouths of rivers.
        - *β*. Formations at the base of cliffs.

1. SANDY BEACHES, ABOVE HIGH TIDE.

(*a*) *The Pes-capræ formation.*—The beach is built up most rapidly at the mouths of rivers. In the case of the Lamao River, for instance, two spits are at present being formed, one on each side; at high tide,

their distal ends are submerged and since the littoral current and waves are sufficiently strong, no vegetation has gained a foothold. However, at the proximal extremities, triangular patches of newly formed beaches above high tide exist, and thereon the best expression of the *Pes-capræ* formation can be observed.

The tropical cosmopolitan creeper, *Ipomoea pes-capræ,* is almost always present. This remarkable plant becomes established at a point lying a few meters landward from the upper limits of high tide, and it may, from a woody base, send out runners in all directions to a distance of as much as 10 meters; these latter take root and thus may become new centers; often their ends reach to the sea, whereupon the portion which is bathed by the salt water is killed back. This plant takes possession by runners and seedlings as rapidly as the beach is formed.

Other creepers found in this formation and having similar habitats are *Spinifex squarrosus* (the porcupine grass) and the legume, *Canavalia obtusifolia.* These plants, in addition to a few weeds, are practically the only ones to be observed on the strand at Lamao, although in similar physiographic situations in other parts of the Islands a greater diversity may be encountered.

The deposit away from the mouth of the river usually is formed with less rapidity, and, correspondingly, the *Pes-capræ zone* then is narrow or entirely absent, although in the older beaches in open places its elements may anywhere be found, excepting at the foot of the cliffs where it is usually wanting. Owing to the small size of the rivers of the Reserve, a rapid formation of the beach does not take place. In many parts of the Islands, where large streams flowing toward an open coast enter the sea, the triangular patches of the *Pes-capræ* formation become much larger, other plants, together with those mentioned, are then present and low dunes none of which, in these Islands, according to my observation, are over 2 meters in height are formed, on which the plants which have just been discussed act as sand binders.

(*b*) *The Barringtonia-Pandanus formation.*—On older portions of the beach, lying back of the *Pes-capræ* formation, or where this is absent fronting on the border of the sea, is the woody vegetation of the beach. This has been named by Schimper[53] the *Barringtonia* formation, from *Barringtonia speciosa.* On the Lamao strand this species is not present, although in similar situations it is common in other portions of the Islands.[54]

The most striking plant of the beach of the Lamao Reserve and in many other parts of the Philippines is *Pandanus tectorius,* and for this reason the formation has been given the above name. Together with

[53] *Loc. cit.,* 391.

[54] Much of the original vegetation of the beach at Lamao has been removed. This species may have been present.

Pandanus, Hibiscus tiliaceus, Erythina indica and *Terminalia catappa* are common. Less frequent are *Pongamia glabra, Thespesia populnea,* and *Heritiera littoralis.* Shrubs such as *Cerbera odollam, Morinda citrifolia,* and *Clerodendron inerme* occupy the edge or the more open places of the beach jungle. The scandent shrub *Quisqualis indica* and the semi-herbaceous vine *Wedelia biflora* are nearly always present. Near small villages, where the beach has been cleared, the introduced thorny *Prosopis julifora* has succeeded in gaining a foothold and in some places it is the only woody species present. Occurring with it, but less abundant, are *Pithecolobium dulce* and *Acacia farnesiana,* both exotics. *Calophyllum inophyllum* which, in some places, appears on the open sandy beaches is, for the Reserve, confined to a more protected shore line. The only specimen of the valuable timber tree *Intsia bijuga* (ipil) which has been observed on the Reserve, was noted in this situation. In clearings in the *Barringtonia-Pandanus* formation are *Ipomoea pescaprae, Canavalia obtusifolia, Spinifex squarrosus,* and the weeds, *Vernonia chinensis, Crotalaria retusa, Scoparia dulcis, Aerua lanata, Portulaca oleracea, Gynandropsis pentaphylla,* and *Datura fastuosa.*

More extensive observations of the vegetation of this formation outside the Reserve show that many plants enumerated by Schimper and others for the Indo-Malay region are also found in the Philippines, although a large number are not present in the limited area under consideration. (See map.)

Genetic relations.—As the beach grows, the plants of the *Barringtonia-Pandanus* formation advance into the *Pes-capræ* zone and eventually replace its vegetation, although the latter may still exist in artificial openings of the former. In the same way, the vegetation of the formation lying behind the beach in time occupies the older portions of the latter; thus, on the Reserve, the plants of the *Bambusa-Parkia* are present therein, although here the artificial conditions render this relationship confusing. Indeed, only the frontal zone of the beach shows a pure expression of the *Barringtonia-Pandanus* formation. As soon as this is penetrated, the character of the vegetation changes and relics of the former vegetative condition are then shown only by scattered individuals of *Pandanus* and the other species.

The beach habitat and the ecological characteristics of the vegetation thereon.—The beach is essentially a xerophytic habitat. This is shown by the stunted condition of trees, the umbrella habit of *Barringtonia speciosa* and *Terminalia catappa,* the fleshy leaves of the *Ipomoea, Canavalia* and others, and the hard, xerophytic leaves of all the tree species.

The factors of the beach habitat which bring about the xerophytic condition of the plants growing thereon are not definitely known. Probably a number of these are operative. Until lately it has been assumed that the plants of the strand and dunes are all halophytes. Investiga-

tions made by Kearney [55] show that the salt content of some sea beaches is indeed so low that he is justified in making the statement that so far as this factor is concerned, plants growing thereon are not halophytes. Walker [56] in studying this question in regard to the Philippine Islands finds only a trace of salt in the soil of the sea beach, and tests made of several specimens of sand from the Lamao strand confirm these results.[57] A surface soil, collected just at the upper limits of high tide, where runners of *Ipomoea* are present, shows 0.25 per cent of sodium chloride; one 6 meters back of this, where seedlings of *Erythrina indica* are abundant, gives only 0.004 per cent of salt; one 9 meters above high tide had a content of 0.005 per cent, and a sample just beneath the surface, 26 meters inland, gave 0.003 per cent. Ordinary, cultivated soil is known to contain from 0.02 to 0.2 per cent of sodium chloride. It is therefore out of the question to assume that the salinity of the strand has brought about the ecological adaptations for many beach plants.

On the other hand, salt spray is known to be deposited in considerable quantities on the leaves of trees growing near the beach. At any time of the year this can be detected by taste, and it is especially noticeable after a typhoon. It is a common observation that considerable quantities of this spray will injure and eventually kill delicate leaves of plants not accustomed to such habitats. During a prolonged typhoon in Manila, comparative observations were made on *Terminalia catappa*, the natural habitat of which is on the seacoast, and *Artocarpus incisa*, which has much more delicate leaves and the natural habitat of which is in more protected situations. The effect of the salt spray on *Terminalia* was hardly noticeable, while the whole of the seaward, and much of the landward, side of *Artocarpus* lost its leaves by a gradual withering, due to the effect of the salt spray. Therefore, leaves of trees growing on the frontal zone of the beaches must have characteristics which will enable them to withstand the physiological drying effect of sodium chloride. Coast lines are essentially windy places. Since no protection is offered to the vegetation, the frontal zone is constantly being exposed to the drying action of strong winds; in this respect it is comparable to the habitat of the ridge vegetation on the mountain and the likeness finds ecological expression in the stunted growth and the often "umbrella-like" shape of the trees.

The incapacity of the sandy soil to hold water is well known and tests of samples of sand from the Lamao beach, taken near the limits of high

[55] Kearney, T. H.: Are plants of sea beaches and dunes true halophytes? *Bot. Gaz.* (1904), **37**: 424–436. See this for literature of the subject.

[56] The coconut and its relation to production of coconut oil. Walker, H. S.: *Phil. Journ. Science* (1906), **1**: 59.

[57] Analyses made by L. A. Salinger of this Bureau. The percentages given are by weight of salt as compared with the air-dry weight of soil.

tide, showed this to be but 21.96 per cent. Reference to the table on page 426 will show this number to be less than one-half of that found for the clay soil of the interior. The sand which was tested had a humus content of 0.22 per cent, which is an exceedingly low figure; soils a few meters back of the situation from which these specimens were taken gave a considerably higher number, and consequently, their capacity to hold moisture is much better.

The sand of the Lamao beach shows a remarkably high percentage of magnetite; in one sample, taken from near the mouth of the river, 76 per cent of the total was composed of this mineral, although farther from the mouth, the percentage would probably be much less.

The effect of the dry season on the vegetation on the beach is marked. During this period, trees such as *Erythina indica* for a time shed their leaves and those of *Terminalia catappa* and *Barringtonia racemosa* redden and many of them drop before the new ones appear; the shoots of *Ipomoea* and other creepers partially or wholly die back and herbaceous weeds are nearly absent. Indeed, as a whole, during the season the thin appearance of the foliage is even more noticeable than it is in the *Bambusa-Parkia* formation. The vegetative activity, after the initiation of the rainy season, is as rapid as it is on the clay soil; runners of *Ipomoea* and *Canavalia* grow with amazing rapidity and seedlings of *Prosopis* and other introduced trees in a short time form thick stands. During this portion of the year both exotic and native plants, derived from many habitats which are much less xerophytic, do surprisingly well in the forest nursery which has been established on the beach. The underground water level of the beach, 30 meters back from the sea, is a little over 2 meters below the surface and at the base of the cliff landward from the sea it is much less. The roots of the trees of the *Barringtonia-Pandanus* formation which I have examined, in a number of instances reached to this level and so they have a constant supply of water upon which to draw. Once the seedling stage passed, no tree having a deeply penetrating root system would suffer from a lack of soil moisture on such a beach.

Another factor which is usually, and no doubt correctly, attributed as a cause promoting the xerophytic structure of beach plants, is strong light, because it increases the rate of transpiration. Copeland[58] has shown that in *Cocos nucifera* the change from a light haze to full illumination frequently multiplies the transpiration by four, and this is brought about by the fact that the leaf is heated above the temperature of the surrounding air. More light, and consequently more heat, reaches the leaves of plants on the beach than it does in the case of those situated in less sandy soils, because the reflection from the bright sand is greater

[58] Copeland, E. B.: On the water relations of the cocoanut palm, *Phil. Journ. Sci.* (1906), 1: 35–37.

than it would be from darker earth; it is also true that the vegetation overhanging the edge of the beach would have its transpiration increased by the increase in the temperature of the leaf because of the reflection from the water at high tide.

Schimper[59] calls attention to the fact that some beach plants are among the trees most commonly cultivated in the Tropics. My observation shows that not only is this true but also that many sea-beach plants are present in certain inland habitats and that in most instances such plants are more vigorous than individuals of the same species growing on the shore.

On the Reserve, isolated trees of such coastal species as *Erythrina indica* and *Pongamia glabra* grow in the forest along streams considerably above the influence of sea water and these trees growing inland are more vigorous than those growing on the coast. *Cycas circinalis*, a common plant of the coastal region in many parts of the Philippines, although not on the beach at Lamao, was collected from two localities at about 900 meters' altitude. A grove of these trees is situated near the top of Limay peak and the individuals there are more thrifty than any I have seen on the beach. *Ipomoea pes-capræ* and *Spinifex squarrosus* are not confined to the strand, but also occupy positions beyond the influence of the sea. Outside the Reserve, the following trees grow both on the beach and inland: *Casuarina equisetifolia*, *Terminalia catappa*, and *Erythrina indica*. *Terminalia*, *Erythrina*, *Calophyllum inophyllum*, and *Barringtonia speciosa* are commonly cultivated in Manila and in other places in the Islands. In all instances the most thrifty trees are those not situated on the seashore. It is evident that where beach plants are propagated inland, they are more thrifty than individuals of the same species growing on the beach and that they can not be considered *xerophilous* in nature, though they are xerophytic. Ordinarily, the struggle for existence in the better soils is too great for them and hence they are driven to the coast, where their plasticity is such as to enable them to adapt themselves to the severe conditions imposed.

It is well known that most of the species common to the seashore have fruits adapted for disposal by water currents. The cosmopolitan nature of beach plants is to be attributed to this fact.

2. THE STRAND LYING BELOW HIGH TIDE.

As the detritus, washed into the sea by rivers reclaims land therefrom, bars may be formed and eventually these may be built above the level of the sea and in this way lagoons are eventually separated which, for a greater or less length of time are kept open by the ebb and flow of tides. Mud flats which often are not cut off from the open sea, are formed in protected bays or re-entrants, where deltas are in the process of building,

[59] *Loc. cit.*, 91.

but in these cases, owing to the fact that the breaker line is far distant from the shore, an area of more or less quiet water intervenes. Wave-cut terraces may be produced at the bases of sea cliffs, and these are often so covered with large boulders as to leave places between the latter fairly well protected from the heavy action of the waves, when the terrace is submerged at high tide. In a word, because of the absence of strong waves, the physiographic situations which have been discussed offer a favorable place for the establishment of plants. In the Tropics, these places are occupied by the well-known Mangrove and Nipa formations.

Within the limits of the Reserve there are three physiographic situations, but, because of the precipitous nature of the coast and the small size of the rivers, there is only a weak development of the Mangrove and Nipa formations. The first stages of the life history of the swamps produced by these plants are here encountered.

(*a*) *The Mangrove and Nipa-Acanthus formation behind sandy beaches.*—Situated at the mouths of the Lamao and Limay rivers, there are small areas having the *Nipa-Acanthus* formation. Although the species comprising this are most in evidence, yet the elements of the mangrove formation are not lacking. The early stages in the development of the vegetation on the strand below high tide and behind beaches, usually show among the first arrivals *Nipa fruticans* (see Pl. XI), the most important plant of the *Nipa-Acanthus* formation. The fruits of this palm have a remarkable capacity for being carried through long distances by shore currents. It is not an uncommon sight to see germinated seeds floating in the water near the beach, or lying on the latter where they have been cast up by the waves but where the dynamic conditions on the strand are too strenuous to admit of their obtaining a foothold. However, if they are carried into lagoon or tidal channels by the flow of the tide, then in these more quiet waters young plants of this species find a favorable place for development. Thus, newly formed lagoons have *Nipa fruticans* among the first pioneers, although, in many instances, grasses and sedge may precede the *Nipa* stage.

Plate XI, shows a condition in which *Panicum repens*, *Fimbristylis ferruginea*, and *Cyperus malaccensis* form the brackish meadow. Such habitats are usually rapidly replaced by the more shrubby growths of several other plants, among which the shrubby creeper *Acanthus ilicifolius*, the hard, prickly, ilex-like leaves of which give a decided character to the formation, may be mentioned. Often, the legumes *Derris uliginosa*, *Caesalpina nuga*, and *Dalbergia torta*, all of which have their origin in soils less salty than that in which *Acanthus* grows, are entangled with the latter and with it, because of their scandent habit, they form dense, jungle-like and thorny thickets, which are difficult to penetrate. The ground rosettes of the fern *Acrostichum aureum* and the amaryllidaceous *Crinum asiaticum* are scattered here and there in the open

places. Among the trees, scattered specimens of *Dolichandrone spathacea*, *Xylocarpus granatum*, *Heritiera litoralis* are clearly elements of both the *Barringtonia* and the *Nipa* formations, but they are not present in the best expression of the mangrove swamps. In small rivers, the mangrove vegetation itself is wanting or poorly developed; thus, at the mouth of the Lamao River, on the Reserve, only isolated species of *Rhizophora conjugata*, *Avicennia officinalis*, and *Sonneratia pagatpat* were noted.

While no further stages in the development of mangrove swamps behind sandy beaches are present at Lamao, yet in many parts of the Philippines these are characteristically the feature of the vegetation at the mouths of large rivers, behind bars along exposed coasts. Their best expression shows the vegetation to be distributed in zones; *Nipa* and its associates occupying the upper limits of high tide, with none of the elements of the mangrove formation, and the latter situated in the more deeply submerged parts of the tidal area. Irregular topography, made by the smaller tidal channels, leaves hummocks at the base of which the elements of the *Nipa* formation may be encountered, on top are representatives of non-halophytic vegetation, while the channel itself is occupied by species of *Rhizophora* or *Bruguiera*.

(*b*) *Mangrove and Nipa formations at the mouths of rivers not behind beaches.*—The mouth of the Alangan River is in a re-entrant across which a subaqueous bar is being formed, which causes the breaker line to be a considerable distance from the shore (see map) and in this the water is comparatively speaking, quiet, especially on its south or more protected side. Here a considerable development of the mangrove formation which is advancing and which in time will fill up the re-entrant, is seen near the mouth of the river. Considerable hydrodynamic force is present, so that much mud has not as yet been accumulated. The substratum is consequently sandy, and this is especially true at the base of the cliffs which will be discussed below.

While the best expression of mangrove swamps is found in muddy deltas yet, as is often assumed, there is no reason to believe that such a soil is requisite for their development. It is far more true that the hydrodynamic factors which prevent the deposit of mud, also establish a too strenuous habitat for the seedling stages of the mangrove species. Other things being equal, the trees can thrive in sandy soils.

(*a*) *Mangrove formations at the mouths of rivers.*—These factors being combined at the mouth of the Alangan River, there is but a poor expression of the mangrove element in that situation. The species present are mostly *Sonneratia pagatpat* and *Avicennia officinalis*. Outside the Reserve, the best representation of this vegetation is found on delta regions at the heads of protected bays. Here the hydrodynamic elements are such as to allow the rapid capture of the newly formed mud flats. The greater the tidal area, the more extensive the advance

of that of the mangrove. In these places, as in the other situations, the *Nipa-Acanthus* formation is at the upper limits of high tide. Nearly all the species common to mangrove swamps which are found in the Indo-Malayan region, are also present in the Philippines, although not on the Reserve.

(β) *Mangrove formation at the base of cliffs.*—On the Lamao Reserve there are a number of shore promontories, at the bases of which wave-cut terraces have been formed, and some of these are thickly set with large bowlders offering a suitable place for the establishment of mangrove plants. The shore currents carrying the seeds or seedlings are likely, with the falling tide, to drop them in one of the interstices. The following species were noted *Aegiceras corniculatum*, *Sonneratia pagatpat*, *Ceriops candolleana*, *C. roxburgiana*, *Bruguiera eriopetala*, and *Avicennia officinalis*. The presence in this strenuous zone of a dilute expression of the mangrove formation in protected patches conclusively shows that the main cause for their absence in the tidal area near sandy beaches is not due to the nature of the soil, but to the hydrodynamic forces there present. However, because of the nature of the habitat no *closed* mangrove swamps can be observed on wave-cut terraces; only isolated trees are here and there encountered. It is even possible that on more open coasts the protection afforded by the bowlders would not be sufficient to allow the invasion of such plants.

Ecological characteristics of mangrove plants.—Schimper [60] has so thoroughly treated the peculiar characters of mangrove plants that here they need only be mentioned. They are as follows: Prevalence of viviparous seeds, pneumatophores, stilt roots, and leathery, usually opposite xerophytic leaves.

The habitat.—Undoubtedly, the main characteristic of the habitat is its salty nature and to this the peculiar formation is due. Whether other factors are operative in giving it this peculiarity is not known. It is possible that, for the edges at least, the reflection of the light from the water enhances the transpiration, but this would not be very effective for the shaded portions. Contrasted with the plants found on sandy strands, those of the mangrove swamps are undoubtedly obligatively halophytic. Observations extended over many miles of beaches show these forms to be only in salty, damp soils. It has been demonstrated that many plants growing on beaches are facultative xerophytes, but it is also true that many of them can also grow in salty soils and are therefore facultative halophytes. Copeland [61] has shown that the coconut roots are, for a short time at least, adapted to resist salt water; whether they could withstand such soils permanently is not known. However, purely mangrove vegetation can not, for any length of time, exist outside of salty soils.

[60] *Loc cit.*, 396–406. [61] Copeland: *Loc. cit.*, 17.

Genetic relations of tidal vegetation.—It has been seen that the tidal estuaries of young rivers in the first stages show elements of the *Nipa* vegetation and that this is followed by the mangrove proper. As the delta formations grow, the mangrove captures the newly made portions and it thus steadily advances seaward. In the meantime, the landward portions of the swamps are being filled by the normal erosive forces and thus the habitat changes and with it, as a consequence, the plant formations. Thus the zone of vegetation behind, replaces *Nipa* and the latter in turn advances on the mangrove. For the Reserve, this is the *parang* of the region immediately behind these swamps. Had the original vegetation in this situation not been removed, then it would take possession. Thus extensive areas, especially the deltas of large rivers which formerly were occupied by mangrove and *Nipa* swamps, are now covered with the mesophytic forests.

Sea-cliff formation.—The vegetation of the sea cliffs has no species peculiar to this situation; rather it partakes of the characteristics of the sandy beaches and of the regions behind them. The windy nature of the habitat evokes a strictly xerophytic type. Trees such as *Vitex littoralis* (molave) (See Pl. XLI), which often occupy a place on the very edge of the cliff, show a much more stunted growth than those in less exposed places. *Erythrina indica*, *Terminalia catappa*, and *Pandanus tectorius* of the beach plants often find lodgment on the cliff. The inland formation furnishes *Parkia roxburghii*, species of bamboo, *Celtis* sp., *Scolopia luzonensis*, *Linociera cumingiana*, *Mimusops elengi*, *Cyclostemon cumingii*, *Cordia blancoi*, *Memecylon edule*, *Glochidon littorale*, *Erioglossum rubiginosum*, and others.

GENERAL CONSIDERATIONS.

Relations to climate.—It has been shown that as one ascends the mountain from the seashore to the summit, distinct climatic belts are encountered and corresponding to these belts are plant formations. The elements of the climate which leave their imprint on the type of vegetation are distinctly those of moisture. From the base up to and including the top, the rainfall and the relative humidity increase and the heat slightly diminishes as one proceeds from below upward. Save on the exposed ridge where the wind causes excessive transpiration, the climatic conditions are for this reason rendered more favorable to vegetation and therefore, one finds a forest more nearly evergreen situated well up on the mountain than one does at its foot and correspondingly, the deciduous and bamboo elements become less pronounced. It may seem presumptuous at this time to make comparisons with the vegetation of other portions of the Islands, yet a hasty trip to parts of the east coast of Luzon previous to and valuation surveys made on the east coast of Mindoro since the collection of data for this paper, clearly show that the climatic formations found well up the slopes of Mount Mariveles are in both the

other places near the sea level. This difference is in direct response to the less-pronounced dry season in these situations. Thus, on the east coast of Tayabas (sub-province Infanta) trees such as *Dipterocarpus grandiflorus* of the *Dipterocarpus-Shorea* formation, *Agathis philippinensis* of the *Shorea-Plectronia* and *Tristira decorticata* of the *Eugenia-Vaccinium* are fairly represented in the forests below 100 meters. On the east coast of Mindoro, *Shorea polysperma* and *Shorea contorta* are not only present near sea level but in many places they have succeeded in obtaining a foothold on old beach lines. In this portion of the Island, also, *Asplenium nidus*, *Ophioglossum pendulum* and associated species are present at the same lower altitude and in the valley of the Tinguan River, in the sub-province of Infanta, near sea level, *Myrmecodia echinata*, *Nepenthes alata*, other related epiphytes and *Decaspermum paniculatum*, are encountered. These examples suffice to illustrate the fact that many plants found on the upper slopes of the mountain are also present near the level of the sea when the moisture conditions are favorable for their existence in this situation. Again, so far as my observation goes, in those places in which the dry season is less pronounced, the very characteristic bamboo forests at the base of Mount Mariveles are entirely absent, being replaced by forests which show a very much less deciduous element. Thus, portions of the east coast of Luzon have no bamboo forests, whereas they are present in other parts where the dry season is pronounced. *Parkia roxburghii*, while it is found scattered in evergreen forests on the east coast of Mindoro, nevertheless shows a change in habit. Instead of being deciduous for two or three months, as is the case at Lamao, there, in many instances, the new leaves appear as soon as the old ones have been shed, and on the dry, sandy soils of old beaches, the interval of time between the shedding of old and the appearance of new leaves was at the time of observation, never more than two weeks.

Relations to topography. -In the discussion of each climatic formation, attention has been called to the physiographic situations in which the vegetation is less or more mesophytic. Thus, exposed ridges and steep exposed slopes have not only drier soils but drier atmospheres, and consequently the vegetation in these places is much thinner and more xerophytic. As the physiographic forces at work bring them into more stable and less exposed conditions, their vegetation will lose its xerophytic character and gradually assume that of the climax vegetation of the formation. The main rivers draining the mountain, cut the climatic formations at right angles and in their beds and in the cañons thus formed, a local climate which is more or less nearly uniform throughout the length of the stream, is produced. The ecological character of the vegetation throughout such river beds and those of the side streams is alike and the latter shows closer relations than are to be found in any one formation in relation to the other vegetation in that formation. This is due to both edaphic and atmospheric characters. The proximity

of the underground water level to the surface makes a common habitat for plants which require this condition. Thus, irrespective of altitude, one finds plants which apparently belong to the low land extending up the stream as far as the habitat goes. Such trees as *Sarcocephalus cordatus*, *Bischofia trifoliata*, *Mangifera altissima*, and *Eugenia luzonensis* are found scattered from near the sea level up to an altitude of approximately 700 meters and they are seldom encountered in other situations.

Ficus minahassæ, other species of *Ficus*, *Leucosyke capitellata*, and *Pipterus asper* are encountered in similar situations from a point near the level of the sea up to 900 meters and *Homonoya riparia* grows in the bed of the stream itself up to the 500-meter line. (See Pl. XLII.)

No doubt, many of these plants would flourish throughout the entire length of the stream, were the edaphic habitat which is necessary for their growth existent at higher altitudes. Aside from the edaphic moisture, the protected position of the cañon renders the atmospheric moisture more uniform and corresponding to this, trees and other plants requiring moisture conditions obtaining in higher altitudes are also present in low ones on the slopes of the cañon farther down the mountain and, at these altitudes, such trees and plants are found in no other situations. The tree fern *Alsophila contaminans*, the very large *Angiopteris crassipes*, and other plants offer striking examples of this fact. (See Pl. XXIV.) Indeed, the vegetation of the river bed and of the cañons in any one climatic formation resembles that of similar habitats in the other formations more than it does that adjacent to it. As yet, the river habitat of the Lamao Reserve is a narrow one. As the mountain more nearly approaches base-level condition, flood plains will be established and thus the edaphic habitat having soil moisture near the surface will be enlarged. A comparison of the Lamao River vegetation with that of the Boñgabon River on the east coast of Mindoro, where the base-level condition has nearly been reached, shows that nearly all tree species, common and peculiar to the habitat near the Lamao River and on the lower slopes of the canyons, reach a much better development near the Boñgabon River flood plain than they do near the Lamao River. Indeed, the vegetation of the Boñgabon River flood plain is that of the Lamao River, spread out. Of course, this larger habitat offers space for more species, but practically all of those found on the narrow margin of the Lamao River are also present in greater numbers near the Boñgabon and there give character to the vegetation.

General conclusions.—Schimper[62] has divided formations into climatic and edaphic, the one depending on the climate, the other on the conditions of soil; thus, within each general climate, there are peculiar conditions of soil such as those pertaining to the mangrove swamps and

[62] Schimper: *Loc. cit.*, 161 and 177.

sandy beaches, which have an especial vegetation more or less independent of the climate in which it grows. Cowles[68] enlarges this idea so as to include all types of topography in the process of destruction and which, consequently, in their present condition, offer unstable and therefore temporary habitats for plants. The vegetative condition will become stable only when base-level conditions are approximated. Thus, the cañons on the one hand have a temporary, mesophytic vegetation and the steep slopes a temporary xerophytic one. The top of the mountain is exceedingly unstable and therefore the vegetation is temporary. Traced to its logical conclusions, the physiography of the entire mountain is very unstable and therefore the vegetation is temporary. With its destruction, it will pass to a more and more permanent condition and the vegetative types will be altered with the change in topography; the climate will then also be different and will more nearly approximate that at present prevalent at the base; and therefore the erosive topography at old age will have a vegetative condition not unlike that of the *Bambusa-Parkia* formation. Just before the death of such a topography, the whole country will be brought nearly to a base-level with the ground water not far from the surface. The vegetative condition will then be not unlike that of a delta region, of which there are many fine examples in the Philippines. At death itself, the mangrove swamps will probably prevail. Of course, the above are only theoretical considerations, yet these erosive stages are approximated in different parts of the Islands so that when logically united the genetic relations of the different vegetative formations can be made clear.

(The work on which this paper was based was performed while the writer was a member of the staff of the Bureau of Science. It was in part written after his transfer to the Bureau of Forestry.)

[68] Cowles, H. C.: The Physiographic Ecology of Chicago and Vicinity. *Bot. Gaz.* (1901), **31**: 75.

ILLUSTRATIONS.

PLATE XXXVII. "Elfin" forest near top of Mount Mariveles. The tree species are mostly *Eugenia congesta*, *Adinandra luzonica*, and *Vaccinium jagori*. Note the rich development of mosses, liverworts, and "filmy" ferns on the trunks of trees. *Eugenia-Vaccinium* formation.

XXXVIII. Epiphytic vegetation on Mount Mariveles. Note the orchid (unknown sp.) on the branch of *Leptospermum amboinense*. On this branch in the center is a seedling of *Vaccinium jagori*; on the right, slightly out of focus, is the orchid *Acoridium tenellum*. A moss, *Erobryum lanosum*, and a small creeping fern, *Humata repens*, are also common on the same branch. Below is a mass of the filmy fern, *Hymenophyllum* sp., now dried up. In this are *Humata*, *Selaginella*, *Rhododendron quadrasianum*, the moss *Leucobryum javense*, and the liverworts *Mastigophora diclados* and *Bazzania praerupta*. *Eugenia-Vaccinium* formation.

XXXIX. Specimen of the bird's-nest fern *Asplenium nidus* growing on *Eugenia acuminatissima*. *Eugenia-Vaccinium* formation.

XL. View at the mouth of the Lamao River. Note the meadow in the center, back of which is the *Nipa-Acanthus* formation. On the left are elements of both Nipa and Mangrove swamps. In the background the bamboo *Bambusa blumeana*.

XLI. View of a sea cliff near the mouth of the Lamao River. The large tree on the edge is *Vitex littoralis* (molave), below it on the right is *Pandanus tectorius*. On the left is *Bambusa lumampao*. The waves and shore currents on the terrace at the base are too strong to permit the mangrove vegetation to obtain a foothold.

XLII. View in the rocky river bed of the Lamao River showing the peculiar habit of *Homonoya riparia*. The floods of the rainy season repeatedly strip this tree of its leaves. The fern shown in the picture is *Callipteris esculenta*.

XLIII. A Leaves of *Buchanania florida*. 1, grows in protected position at 180 meters; 2, taken from a tree growing on an exposed ridge at 914 meters. B Leaves of *Calophyllum whitfordii*. 1, taken from tree on a protected ridge at 640 meters; 2, taken from a tree growing on a protected ridge at 1,100 meters; 3, taken from a tree on an exposed peak at 914 meters; two-thirds natural size.

XLIV. A Leaves of *Myrica rubra*. 1 and 2 from the same tree at 640 meters; 1, from the lower shaded branches, and 2 from an upper branch; 3, taken from a tree at 1,150 meters. B Leaves of *Ternstroemia toquian*. 1, taken from a tree on exposed peak at 920 meters; 2, from a tree on protected slope at 640 meters; two-thirds natural size.

XLV. A- 1, 2, and 4, leaves of tree *Eugenia acuminatissima*; 1, taken from tree growing on protected slope at 940 meters; 2, at 815 meters, and 4, at 1,060 meters; 3, leaf of tree of *Eugenia acuminatissima* var. *parva*, taken from a tree growing on exposed peak at 920 meters. B Leaves of *Eugenia congesta*. C-1, leaves of tree of *Leucosyke capitellata* var. *celtidifolia* growing on edge of a cliff at 920 meters; 2, leaf of *Leucosyke capitellata* growing near the bottom of the river cañon at 635 meters. Two-thirds natural size.

PLATE XXX.

Plate XXXI

PLATE XXXII.

PLATE XXXII

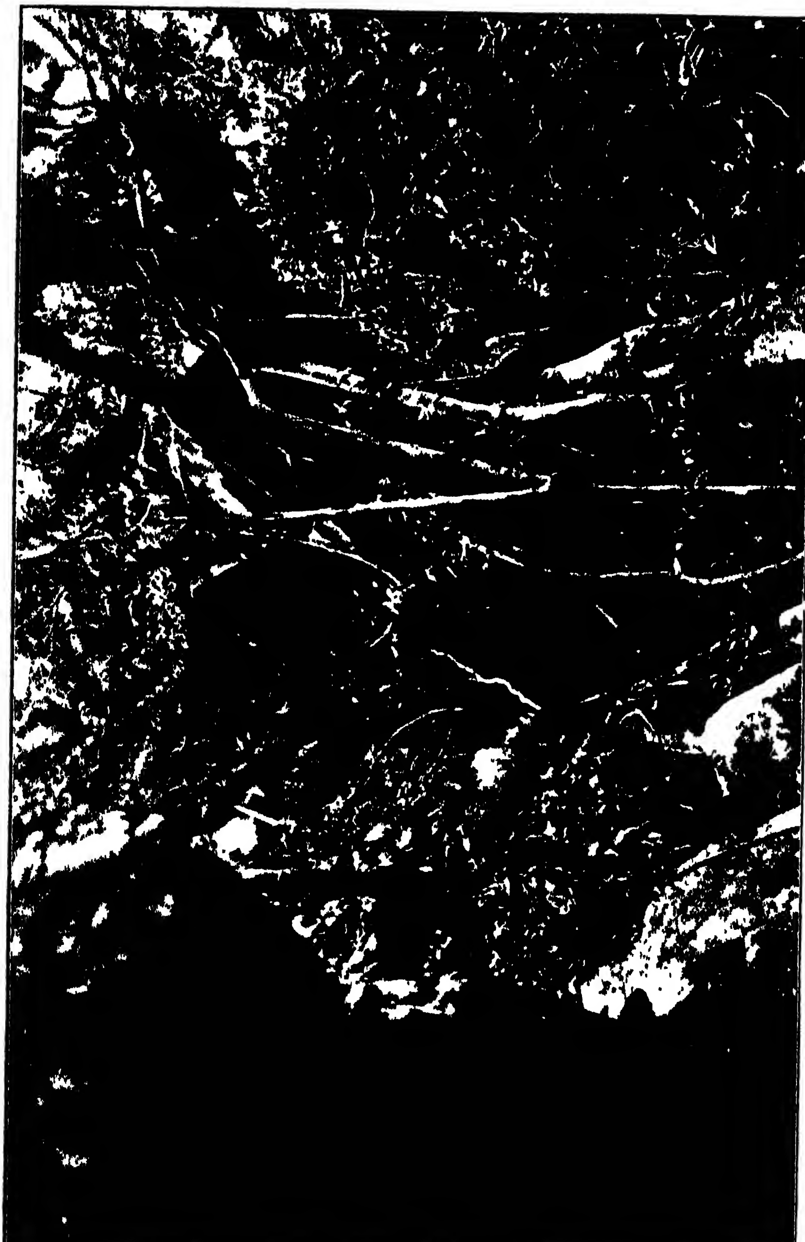
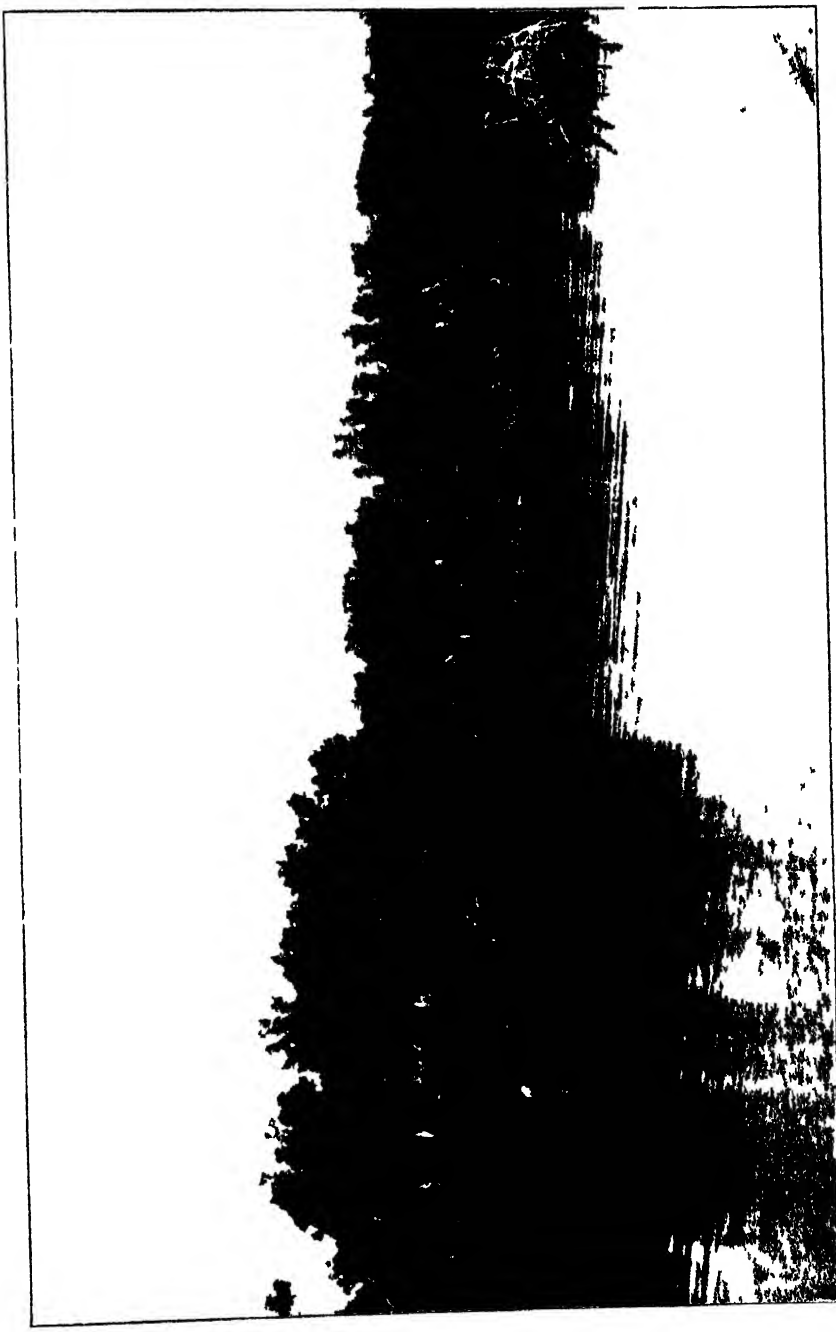
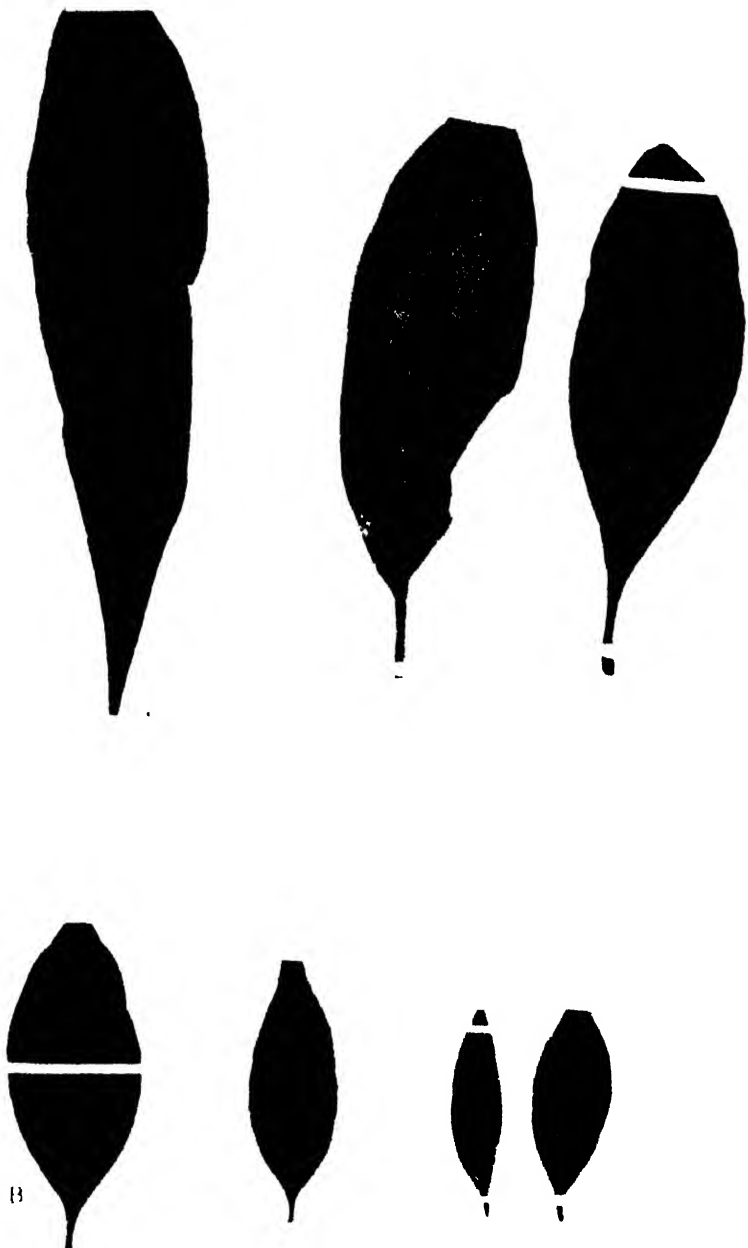
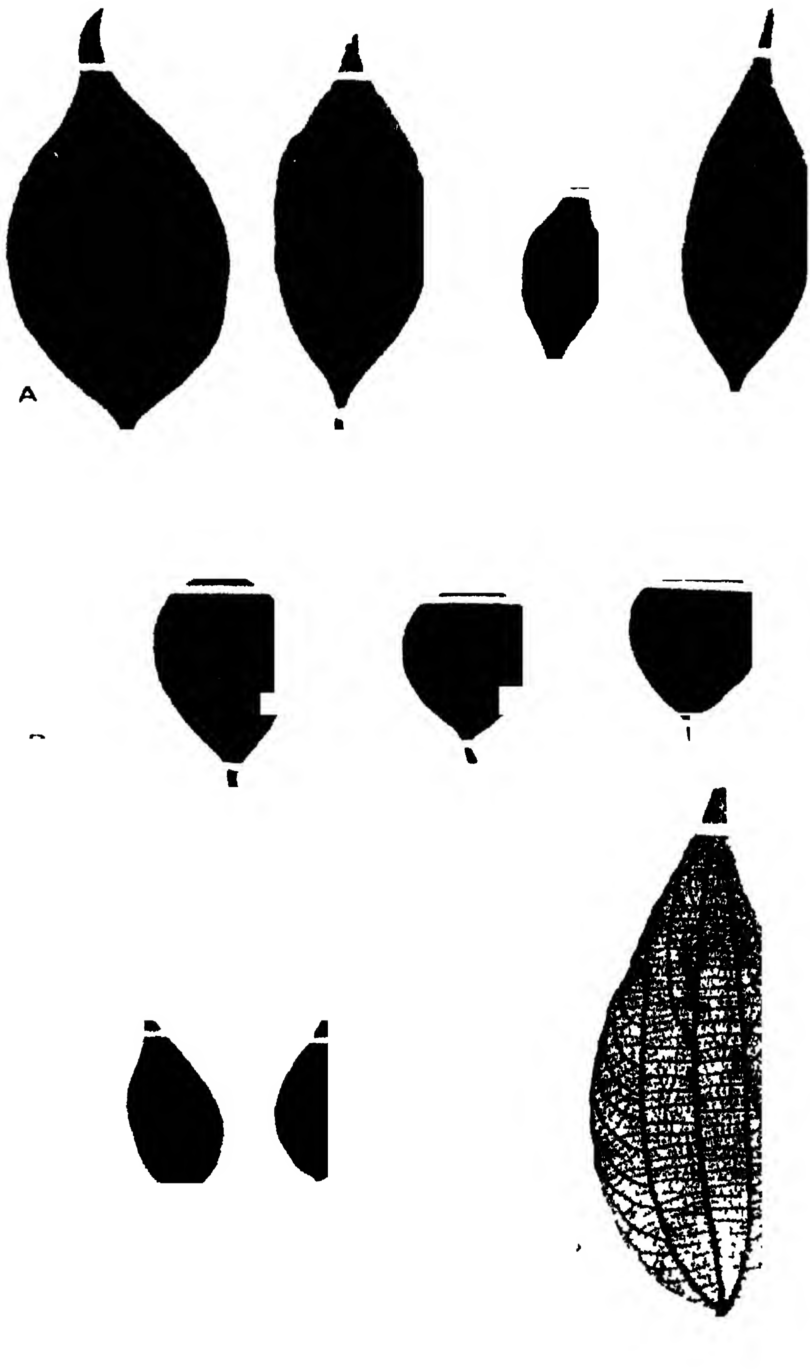


PLATE XXXVI.

PLATE XXXI




B


A

A CATALOGUE OF PHILIPPINE HYMENOPTERA, WITH DESCRIPTIONS OF NEW SPECIES.

By Robert E. Brown, S. J., *Manila Observatory.*

In 1885, Don Ramon Jordana published in Madrid a work entitled "Bosquejo geográfico é histórico-natural del Archipiélago Filipino," in which he tabulated all the species then known to belong to the Philippine fauna. The order *Hymenoptera* was very poorly represented, no more than some thirty species being given as having been met with in the Philippines and none of these were characteristic. Ten years later, on the occasion of the exposition which was held in Manila in 1895, Father Castro de Elera, O. P., published another catalogue of the fauna of the Islands, which he entitled "Catálogo sistemático de toda la fauna de Filipinas conocida hasta el presente." This work is much more pretentious and complete than that of Señor Jordana, though it is somewhat marred by the inclusion of many exotic forms which were contained in the Museum of the University of Saint Thomas; and although Father Elera explains this in the subtitle and notes the exotic species in the body of the work, still, unless one has this constantly before one's mind, the impression is gained that the number of Philippine species is greater than it really is. In the catalogue of the *Hymenoptera* which is given in the second volume, pages 238-247, Father Elera enumerates fifty-four species as representing the known Philippine insects of this order. This is not quite correct, as he had inadvertently overlooked a paper published by Professor Emery in the Annals of the Entomological Society of France in 1893 in which forty-one species of ants are recorded from the Island of Luzon, principally from Manila and Antipolo.

This then brought the *Hymenoptera* known in the Archipelago up to the year 1895 to the number of ninety-five.

In 1903, Rev. William Stanton, S. J., at that time Assistant Director of the Philippine Weather Bureau, began to study in his spare time the *Hymenoptera* which he collected in the garden attached to the Observatory. He discovered many forms which he did not recognize, and, being unable to classify them owing to the lack of literature on the subject, he sent his specimens to Dr. William Ashmead, of the National Museum, Washington, who found that the great majority of the species were entirely new to science and that almost all the remainder were not before recorded from the Islands.

Father Stanton continued the work till April, 1904, when he was obliged to return to the United States, but in the short time he had been collecting he had discovered no less than five new genera and sixty-eight new species.

The descriptions of the earlier of these new species were published by Dr. Ashmead in the Journal of the New York Entomological Society and of the later collections in the Canadian Entomologist and the Proceedings of the United States National Museum.

When Father Stanton left the Philippines, the writer continued his work and as a consequence the number of new genera and new species has greatly increased; in fact, from December to June, which constitutes the best collecting season, the average of new species was one per day and of new genera three every two months.

The number of species in the adjoined catalogue is 458. Many are included which were not contained in Dr. Ashmead's check list, as he had apparently overlooked several recorded by Kohl, Ritsema, and Radoszkowski, while species not before recorded from the Philippines are being constantly discovered. However, this number does not represent the complete hymenopterous fauna, for the writer has in his possession some thirty-nine new species which have not as yet been described, while the Entomological section of the Bureau of Science has many more undescribed forms.

After the name of the species discovered since 1903 I have placed the name of the collector and in the case of those found by Father Stanton and the writer, M. O., to show that they were obtained from the garden of the Manila Observatory. At the end of the catalogue will be found a list of some of the hosts from which a few of the new species were bred in the Observatory.

Superfamily III. **VESPOIDEA**.

Family XXVII. CEROPALIDÆ.

Subfamily III. Aporinæ.

Tribe I. Anoplini

TACHYPOMPILUS Ashmead.

Tachypompilus ashmeadii sp. nov. ♀ Length, 14–16 millimeters. Head, thorax, and part of abdomen black, last 3 segments of abdomen brick red, covered with sparse pubescence, the pubescence consisting of straight, longish hairs; head smooth, pronotum lightly rugose, scutellum, metanotum and abdomen finely punctate, shining. Clypeus truncate, smooth. Scape stout, first joint of flagellum twice as long as the second, front face long, with a deep medial furrow. Anterior face of metathorax convex, posterior face concave with the angles obtusely dentate. Wings hyaline with nervules fuscous, median and submedian cells of equal length. Three cubital cells, first almost triangular, second quadrangular and third very large; hind tibia sparsely armed with spines, first joint of hind tarsi as long again as any of the rest, claws reddish. Manila.

Family XXXI. CHRYSIDIDÆ.

Subfamily II. CHRYSIDINÆ.

CHRYSIS Linn.

Chrysis miri sp. nov. ♂ Length, 6.5 millimeters. Near to *C. mendicalis* Cameron. Head, thorax, first and third abdominal segments, light metallic blue; space around ocelli, a few punctures on collar and pronotum, medial area of scutellum and second abdominal segment purple; round spot and apical margin of third segment purple, with a transverse line on basal area of second segment, dark purple.

Antennæ black, the scape in front and two basal joints of flagellum light bronze green; coxæ and femora of front legs metallic green; tibiæ slightly green; tarsi dark brown, tibia with slight cinerous pubescence; hind legs green, tarsi brownish. Head and thorax with closely set, coarse punctures, with smaller ones scattered up and down, the punctures larger on posterior portion of thorax, smaller on the abdomen and very symetrically arranged The ventral segments very finely punctate, with a brown medial longitudinal ridge along all the segments

Antennæ thick, the third joint of the flagellum as long again as the second Pronotum broad, very much rounded anteriorly, medial area of mesonotum separated from the lateral areas by longitudinal rows of purple punctures; scutellum and post-scutellum convex, posterior portion of post scutellum very much rounded.

First abdominal segment with a medial wide and deep depression anteriorly. Apical segment of third segment with 3 teeth, one on each angle and one in the middle, the intervals between the teeth sinuate.

Family XLII. MUTILLIDÆ.

Subfamily I. MUTILLINÆ.

MUTILLA Linn.

Mutilla manilensis sp nov. This species comes very near to *M ricinissima* Gribodo but is differentiated by the size of the maculæ and the bands of pubescence on the third and fifth segments ♀ Length, 7.5 millimeters. Head broader than thorax. Head and thorax coarsely, abdomen finely, punctured. Scape, femora, head posteriorly, thorax and abdomen densely pubescent. Head, antennæ, abdomen and legs black, thorax red, pubescence on abdomen cinerous, on legs and antennæ whitish.

The second abdominal segment above with 2 small, round, silvery maculæ, the third and fifth segments covered with transverse bands of silvery pubescence. The first ventral segment with a prominent longitudinal carina, the fourth and fifth segments coarsely punctate posteriorly and striated anteriorly.

Mutilla parva sp. nov. Near to *M. decora* Smith. ♀ Length, 1.5 millimeters Head and abdomen finely, and thorax coarsely, punctate and sparsely pubescent, the pubescence consisting of thin, long, curved hairs. Eyes, large, oval; thorax very much rounded, abrupt anteriorly and with a steep slope posteriorly; head and antennæ black, except the scape which is rufous covered with whitish pubescence; legs, except the femora, and abdomen black, thorax red.

A small oval silvery white spot in the middle above on the second abdominal segment, a transverse band of silvery white pubescence which is interrupted medially on its posterior margin, and the third segment also covered with the white pubescence. First, third, and fourth ventral segments strongly longitudinally carinate.

Order HYMENOPTERA.

Suborder I. **Heterophaga** Ashmead.

Superfamily I. APOIDEA.

Family I. APIDÆ.

Megapis dorsata Fabricius.
zonata Smith.
Apis indica Fabricius.
mellifera Linnaeus.
nigrocincta Smith.
unicolor Latreille.
Micrapis florea Fabricius.
Trigone biroi Friese.
Melipona laeviceps Smith.

Family II. BOMBIDÆ.

Bombus mearnsi Ashmead; E. A. Mearns.

Family V. ANTHOPHORIDÆ.

Anthophora cingulata Fabricius.
zonata Linnaeus

Family VI. NOMADIDÆ.

Crocisa emarginata Lepeletier.
lamprosoma Boisduval.
nitidula Fabricius.
Nomada lusca Smith.
philippinensis Vachal.
Nomia dimidiata Vachal.

Family VII. CERATINIDÆ.

Ceratina compacta Smith.
hieroglyphica Smith.
imperialis Ashmead; M. O.
philippinensis Ashmead; M. O.
sexmaculata Smith.
tropica Ashmead; M. O
Allodape jucunda Smith.
minutior Ashmead; M. O.
philippinensis Ashmead; M. O.

Family VIII. XYLOCOPIDÆ.

Xylocopa aestuans Linnaeus.
adusta Perez.
amauroptera Perez.
bombiformis Smith.
bryorum Fabricius.
Xylocopa dissimilis Lepeletier.
euchlora Perez.
fuliginosa Perez.
ghilianii Gribodo.
latipes Fabricius.
occipitalis Perez.
philippinensis Smith.
sonorina Smith.
sulcifrons Perez.
rufescens Smith.
tricolor Ritsema.
trifasciata Gribodo.
vachali Perez.
Platynopoda latipes Drury.
tenuicornis Westwood.

Family IX. MEGACHILIDÆ.

Megachile atrata Smith.
clotho Smith.
hera Bingham.
lachesis Smith.
laticeps Smith.
robbii Ashmead; M. L. Robb.
Ctenoplectra vagans Cockerell.

Family X. STELIDÆ.

Coelioxys manilae Ashmead; M. O.
philippinensis Bingham.

Family XII. ANDRENIDÆ.

Hoplonomia quadrifasciata Ashmead, M. O.
Paranomia stantoni Ashmead; M. O.
Halictus manilae Ashmead; M. O.
robbii Ashmead; M. L. Robb.

Family XIV. PROSOPIDÆ.

Prosopis tagala Ashmead; C. S. Banks.

Superfamily II. SPHECOIDEA.

Family XV. OXYBELIDÆ.

Notoglossa banksi Ashmead; C. S. Banks.

Family XVI. CRABRONIDÆ.

Subfamily III. Crabroninæ.

Crabro quadriceps Bingham.
venans Kohl.

Subfamily IV. Rhopalinæ.

Dasyproctus philippinensis Ashmead; M. O.
Rhopalum albocollaris Ashmead; M. O.

Family XVII. PEMPHREDONIDÆ.

Psen algii Ashmead; M. O.

Family XVIII. BEMBICIDÆ.

Bembex borrei Handlsch.
melancolica Smith.

Family XIX. LARRIDÆ.

Subfamily I. Larrinæ.

Notogonia laboriosa Smith.
manilae Ashmead; M. O.
subtessalata Smith.
Larra aurata Fabricius.
Threosphex stantoni Ashmead; M. O.

Subfamily IV. Pisoninæ.

Pison lagunae Ashmead; M. O., P. L. Stangl.
punctatus Ashmead; M. O.
Pisonitus argenteus Ashmead; P. L. Stangl.
Pisonoides browni Ashmead. M. O.

Family XX. PHILANTHIDÆ.

Subfamily I. Cercerinæ.

Cercetis vafra Bingham.

Family XXI. TRYPOXYLIDÆ.

Trypoxylon bicolor Smith.
elongatum Ashmead; M. O.
philippinensis Ashmead; M. O.

Family XXII. MELLINIDÆ.

Megalomma quadricinctum Ashmead; M. O.

Family XXV. SPHECIDÆ.

Subfamily I. Sphecinæ.

Sphex argentata Dahlbom.
aurulentus Fabricius.
(*a*) *var.* ferrugineus Lepeletier.
(*b*) *var.* lineolus Lepeletier.
sericeus Fabricius.
sulciscuta Gribodo.
splendidus Kohl.
umbrosus Christ.
(*a*) *var.* plumbiferus Costa.
(*b*) *var.* rufipennis Fabricius.
Chlorion lobatum Fabricius.

Subfamily II. Ammophilinæ.

Ammophila atripes Smith.
coronata Costa.
superciliaris Saussure.

Subfamily III. Sceliphroninæ.

Sceliphron bengalensis Dahlbom.
madraspatanum Fabricius.
var. conspicillatum Costa.
violaceum Fabricius.
Chalybion violaceum Dahlbom.

Family AMPULICIDÆ.

Subfamily Ampulicinæ.

Ampulex compressa Fabricius.
laevigata Kohl.
sonneratii Kohl.

Superfamily III. Vespoidea.

Family XXVII. CEROPALIDÆ.

Subfamily I. Pepsinæ.

Salius flavus Fabricius.
graphicus Smith.
pulchripennis Smith.
Hemipepsis tagala Gribodo.
Pallosoma fulgidipennis Saussure.
Pseudosalius bipartitus Lepeletier.
Caligurgus sericosoma Smith.

Subfamily II. Ageniinæ.

Macromeris argentifrons Smith.
splendida Lepeletier.
violacea Lepeletier.

Pseudagenia femorata Ashmead; M. O.
imitator Ashmead; M. O.
rufofemorata Ashmead; M. O.
unifasciata Ashmead; M. O.
Spilopompilus stantoni Ashmead; M. O.
Agenia cingulata Ashmead; M. O.

Subfamily III. APORINÆ (*Pompilinæ*).

Tribe I. *Anopliini.*

Tachypompilus ashmeadii Brown, M. O.

Family XXVIII. VESPIDÆ.

Subfamily I. VESPINÆ.

Vespa analis Fabricius.
annulata Smith.
cincta Fabricius.
deusta Lepeletier.
luctuosa Saussure.
nigripennis Saussure.
philippinensis Saussure.
Provespa doryloidea Saussure.

Subfamily II. POLISTINÆ.

Polistella manilensis Saussure.
Polistes dubius Saussure.
hebraeus Fabricius.
philippinensis Saussure.
Icaria cagayanensis Ashmead; M. O.
philippinensis Saussure.
speciosa Saussure.

Family XXIX. EUMENIDÆ.

Subfamily IV. EUMENINÆ.

Eumenes conica Fabricius.
curvata Saussure.
fulvipennis Smith.
gracilis Saussure.
pomiformis Fabricius.
Rhynchium argentatum Fabricius.
atrum Saussure.
Lionotus dyscherus Saussure.
punctum Saussure.
xanthozonatus Ashmead; M. O.
Ancistrocerus bizonatus Boisduval.
Odynerus punctum Saussure.

Family XXXI. CHRYSIDIDÆ.

Subfamily II. CHRYSIDINÆ.

Stilbum cyanurum Fabricius.
amethystinum Fabricius.
splendidum Fabricius.
Chrysis fuscipennis Brullé.
miri Brown; M. O.
oculata Fabricius.
var. sumptuosa Gribodo.
triacantha Mocsary.
Trichrysis aspera Brullé.
Hedychrum stantoni Ashmead; M. O.

Family XXXII. BETHYLIDÆ.

Subfamily I. BETHYLINÆ.

Dissomphalis tibialis Ashmead; M. O.
Epyris tagala Ashmead; C. S. Banks.
Giniozus philippinensis Ashmead; M. O.

Subfamily II. DRYININÆ.

Dryinus brownii Ashmead; M. O.
stantoni Ashmead; M. O.

Family XXXIII. TRYGONALIDÆ.

Trigonalys lachrymosa Westwood.

Family XXXVI. SCOLIIDÆ.

Discolia aureipennis Lepeletier.
erratica Smith.
modesta Smith.
Scolia aurulenta Smith.
capitata Guerin.
grossa Fabricius.
manilae Ashmead; M. O.
modesta Smith.
procera Illiger.
var. bimaculata Gribodo.
pseudoforaminata Gribodo.
quadrifasciata Fabricius.
quadripustulata Fabricius.
rubiginosa Fabricius.
scutellaria Gribodo.
whiteheadii Bingham.

Subfamily II. Elidinæ.

Elis albicollis Christ.
annulata Fabricius.
aureicollis Lepeletier.
aurulenta Smith.
grossa Smith.
luctuosa Smith.
quadrifasciata Fabricius.
reticulata Cameron.
Liacos analis Fabricius.

Family XXXVII. TIPHIIDÆ.

Tiphia compressa Smith.
intrudens Smith.

Family XLII. MUTILLIDÆ.

Subfamily II. Mutillinæ.

Mutilla accedens Sichel.
analis Lepeletier.
dimidiata Lepeletier.
discreta Cameron.
luzonica Radoszhowski.
maculosofasciata Saussure.
manilensis Brown: M. O.
parva Brown: M. O.
philippinensis Smith.
semperi Ashmead: M. O
suspiciosa Smith.
Trogaspidia bicolor Ashmead. C. S Banks.
minor Ashmead: C. S. Banks.

Superfamily IV. Formicoidea.

Family XLIV. PONERIDÆ.

Subfamily I. Ponerinæ.

Ponera luteipes Mayr.
Microponera nigriceps Ashmead: M. O.

Subfamily II. Pachycondylinæ.

Diacamma geometricum.
var. viridipurpureum Emery.
versicolor Smith.
Odontoponera denticulata Smith.
transversa Smith.
Bothroponera glabripes Emery.

Family XLV. ODONTOMACHUS.

Odontomachus haematodes Linnaeus.
infandus Smith.
papuans Emery.

Family XLVI. MYRMICIDÆ.

Subfamily I. Pseudomyrmicinæ.

Sima allaborans Walker.

Subfamily II. Myrmicinæ.

Monomorium destructor Jerdon.
Pheidole simoni Emery.
Cremastogaster bicolor Mayr.
crassicornis Emery.
longiclava Emery.
ochracea Mayr.
semperi Emery.
simoni Emery.
Pheidologeton diversus Jerdon.
pygmaeus Emery.
var. albipes Emery.
Plagiolepis longipes Jerdon.
Tetramorium guinensis Talrimis.
pacificum Mayr.
subsp. subscabrum Emery.
Solenopsis geminata Fabricius.

Family XLVIII. DOLICHODERIDÆ.

Dolichoderus bituberculatus Mayr.
tuberculatus Mayr.
Technomyrmex albipes Smith.
Tapinoma melanocephalum Fabricius.

Family XLIX. FORMICIDÆ.

Subfamily II. Camponotinæ.

Camponotus cinerascens Fabricius.
gigas Latreille.
nigricans Roger.
pallidus Smith.
platypus Roger.
pennsylvanicus De Geer *var.* japonicus Mayr.
quadrisectus Smith.
Oecophylla smaragdina Fabricius.
var. subnitida Emery.
Calobopsis albocincta Ashmead; M. O.
pubescens Mayr.
Dinomyrmex gigas Latreille.

Polyrhachis abdominalis Smith.
aciculata Smith.
argentia Mayr.
armata Le Guillon.
bicolor Smith.
bihamata Drury.
cyaniventrus Drury.
dives Smith.
maligna Smith.
mayri Roger.
philippinensis Smith.
pubescens Mayr.
rastellata Smith.
sexspinosa Latreille.
trinax Roger.
subsp. javana Mayr.
subsp. sayonensis Forel.

Subfamily III. Formicinæ.

Plagiolepis longipes Jerdon.
Aphomyrmex emeryi Ashmead; M. O.
Formica quadrisecta Smith.
rubra Fabricius.

Superfamily V. Proctotrypoidea.

Family LIV. DIAPRIIDÆ.

Diapria manilae Ashmead; M. O.
pallida Ashmead; M. O.
philippinensis Ashmead; M. O.
tagala Ashmead; M. O.
Galesus luzonicus Ashmead; M. O.

Family LV. CERAPHRONIDÆ.

Ceraphron manilae Ashmead; M. O.

Family LVI. SCELIONIDÆ.

Subfamily III. Teleasinæ.

Prosacantha roberti Ashmead; M. O.

Subfamily IV. Scelioninæ.

Macroteleia manilensis Ashmead; M. O.
Opisthacanta manilae Ashmead; M. O.
nigriclavata Ashmead; M. O.
Telenomus catacanthae Ashmead; M. O.
Hoploteleia pacifica Ashmead; M. O.
Hadronotus flavipes Ashmead; M. O.
luteipes Ashmead; M. O.
Scelio philippinensis Ashmead; M. O.

Family LVII. PLATYGASTERIDÆ.

Anopedias luzonicus Ashmead; M. O.

Superfamily VI. Cynipoidea.

Family LVIII. FIGITIDÆ.

Subfamily V. Eucoelinæ.

Pentamerocera pacifica Ashmead; M. O.
Hexamerocera kiefferi Ashmead; M. O.
philippinensis Ashmead; M. O.
Kleidotoma philippinensis Ashmead; M. O.

Subfamily VI. Xystinæ.

Loboscelidia rufescens Westwood.

Superfamily VII. Chalcidoidea.

Family AGAONIDÆ.

Subfamily I. Agaoninæ.

Kradibia browni Ashmead; M. O.

Family LXI. TORYMIDÆ.

Subfamily I. Idarninæ.

Sycoryctes philippinensis Ashmead; M. O.
Philotrypesis ficicola Ashmead; M. O.

Subfamily IV. Podagrioninæ.

Podagrion philippinensis Ashmead; M. O.

Subfamily V. Megastigminæ.

Megastigmus immaculatus Ashmead; M. O.

Family LXII. CHALCIDIDÆ.

Subfamily I. Leucospidinæ.

Leucospis regalis Westwood.

Subfamily II. Chalcidinæ.

Chalcis albotibialis Ashmead; M. O.
argentifrons Ashmead; M. O.
banksi Ashmead; C. S. Banks.
obscurata Walker.
prodeniae Ashmead; M. O.
pulchripes Holmgren
xerxena Walker.
Stomatocera sulcata Ashmead; M. O
Arretocera stantoni Ashmead, M. O.
Neochalcis tarsalis Walker.
Haltichella ludlowae Ashmead; Miss C. S. Ludlow.
nasuta Holmgren.
validicornis Holmgren
Dirhinus anthracia Walker.
auratus Ashmead, M. O.

Family LXIII. EURYTOMIDÆ.

Eurytoma albotibialis Ashmead C S Banks.
banksi Ashmead. C S Banks.
carinatifrons Ashmead. M O.
manilae Ashmead; M O
systolodes Ashmead, M. O

Family LXV EUCHARIDÆ.

Chalcura aegineta Walker.
nasua Walker.

Family LXVI. MISCOGASTERIDÆ.

Subfamily III. Miscogasterinæ.

Omerocerus pallidipes Ashmead; M O
Nesoloxeuma petiolata Ashmead, M. O.

Family LXVII. CLEONYMIDÆ.

Subfamily II. Cleonyminæ.

Epistenia ania Walker.
feretius Walker.

Family LXVIII. ENCYRTIDÆ.

Subfamily I. Eupelminæ.

Metapelma gloriosa Westwood
Calosoter amenetus Walker.
Anastatus cyaneicollis Ashmead; M. O.
stantoni Ashmead; M. O.
Eupelmus albipes Ashmead; M. O.

Subfamily II. Encyrtinæ.

Taftia prodeniae Ashmead; M. O
Howardiella tarsata Ashmead; M. O.
Ooencyrtus papilionis Ashmead; M. O
Coccidencyrtus manilae Ashmead; M. O.
Aphidencyrtus pallidipes Ashmead; M. O.
Aphycus albiclavatus Ashmead; M. O.
Apterencyrtus pulchricornis Ashmead; M. O.
Exoristobia philippinensis Ashmead; M. O.

Family LXIX. PTEROMALIDÆ.

Subfamily IV. Spalanginæ.

Nesospalangia aptera Ashmead; M. O.

Family LXX. ELASMIDÆ.

Elasmus philippinensis Ashmead; M O

Family LXXI. EULOPHIDÆ.

Subfamily I. Entedoninæ.

Closterocerus brownii Ashmead; M. O
Ascecodes elasmi Ashmead; M. O.

Subfamily II. Aphelininæ.

Aspidiotiphagus aleyrodis Ashmead; M. O.

Subfamily III. Tetrastichinæ.

Tetrastichus flavobasalis Ashmead; M. O.
philippinensis Ashmead. M. O.
Tetrastichodes brownii Ashmead; M. O.
manilensis Ashmead. M. O.
Ceranisus incertus Ashmead; M. O.
Gyrolasia tagala Ashmead; M. O.
Hyperteles flavipes Ashmead; M. O.

Subfamily IV. Elachertinæ.

Nesolynx flavipes Ashmead; M. O.
Euplectrus manilae Ashmead; M. O.
philippinensis Ashmead; M. O.

Superfamily VIII. ICHNEUMONOIDEA.

Family LXXIV. EVANIIDÆ.

Subfamily I. EVANIINÆ.

Evania annulipes Ashmead; M. O.
appendigaster Linnaeus.
impressa Schletterer.
verrucosa Schletterer.

Family LXXVI. ICHNEUMONIDÆ.

Subfamily I. ICHNEUMONINÆ.

Tribe II. *Ichneumonini.*

Cratichneumon manilae Ashmead; M. O.
Elasmognatha cephalotes Ashmead; M. O.

Subfamily II. CRYPTINÆ.

Tribe II. *Phygadeuonini.*

Apsilops nigriceps Ashmead; M. O
Isotima albicincta Ashmead; M. O
albifrons Ashmead; M. O.
cincticornis Ashmead; M. O.

Tribe III. *Hemitelini.*

Chriodes oculatus Ashmead; M. O
Strepsimallus bicinctus Ashmead, M. O.
Paraphylax fasciatipennis Ashmead; M. O
flavus Ashmead; M. O.
Acanthohemiteles benjamini Ashmead, M. O.
Astomaspis metathoracica Ashmead; M. O.
Microcryptus praepes Bingham.
Otacustes alboannulus Ashmead; M. O.
Bathythrix striatus Ashmead; M. O
Diatora prodeniae Ashmead; M. O.

Tribe VI. *Cryptini.*

Agrothereutes albicoxis Ashmead; M. O.
albipalpis Ashmead; M. O.
nigritarsis Ashmead; M. O.
unifasciatus Ashmead; M. O.
Agrothereutes verticalis Ashmead; M. O.
Chromocryptus albomaculatus Ashmead; M. O.

Tribe VII. *Mesostenini.*

Mesostenus leucozonatus Ashmead; M. O.
Mesostenoideus literatus Brullé.
octozonatus Ashmead; M O.

Subfamily III. PIMPLINÆ.

Tribe III. *Lissonotini.*

Atropha clypearia Ashmead; M. O.
Amauromorpha metathoracica Ashmead; M O.

Tribe IV. *Pimplini.*

Xanthopimpla kriegeri Ashmead; M. O
Pimpla punctum Brullé.
Colpomeria flava Ashmead; M. O.

Tribe V. *Xoridini.*

Kriegeria heptazonata Ashmead; M. O

Subfamily IV. TRYPHONINÆ.

Tribe X *Metopiini.*

Metopius browni Ashmead; M. O.

Subfamily V. OPHIONINÆ.

Tribe II. *Ophionini*

Enicospilus ashbyi Ashmead; Ashby.
pacificus Ashmead; M. O.

Tribe IV. *Anomalini.*

Atrometus minutus Ashmead; M. O.

Tribe IVa. *Nesomesochorini.*

Nesomesochorus oculatus Ashmead; M. O.

Tribe V. *Campoplegini.*

Charops longiventris Ashmead; M. O.
papilionis Ashmead; M. O.

Tribe VIII. *Mesochorini.*

Mesochorus philippinensis Ashmead; M. O.

Tribe IX. *Porizonini*

Leptopygus stangli Ashmead; P. L. Stangl.
Temelucha philippinensis Ashmead; M. O.

Tribe X. *Pristomerini.*

Pristomerus flavus Ashmead; M. O.

Family LXXVII. ALYSIIDÆ.

Subfamily II. ALYSIINÆ.

Tribe I. *Alysini.*

Aclisis pleuralis Ashmead; M. O.
Goniarcha malayensis Ashmead; M. O.

Tribe II. *Alloeini*

Asobara försteri Ashmead, M. O.

Family LXXXVIII. BRACONIDÆ.

Subfamily IV. METEORINÆ

Meteorus bacoorensis Ashmead; P. L. Stangl
browni Ashmead, M. O.

Subfamily V. MACROCENTRINÆ.

Tribe I. *Macrocentrini*

Macrocentrus philippinensis Ashmead; M. O.

Subfamily VI. HELCONINÆ.

Tribe I. *Helconini.*

Euscelinus manilae Ashmead; M. O.
Cenocoelius albitarsis Ashmead; M. O.

Subfamily VIII. SIGALPHINÆ.

Fornicia annulipes Ashmead; M. O.

Subfamily IX. CHELONINÆ.

Chelonus albicinctus Ashmead; M. O.
semihyalinus Ashmead; M. O.
Phanerotoma albiscapa Ashmead; M. O.
philippinensis Ashmead; M. O.

Subfamily X. AGATHIDINÆ.

Tribe I. *Agathidini.*

Cremnops collaris Ashmead; M. O.

Tribe II. *Microdini*

Stantonia flava Ashmead, M. O.

Subfamily XI. CARDIOCHILINÆ.

Cardiochiles philippinensis Ashmead; M. O.

Subfamily XII. MICROGASTERINÆ.

Glyptapanteles manilae Ashmead, M. O.
Apanteles manilae Ashmead; M. O.
philippinensis Ashmead, M. O.
Urogaster albinervis Ashmead; M. O.
opacus Ashmead; M. O.
philippinensis Ashmead, M. O.
stantoni Ashmead; M. O.
Microplitis manilae Ashmead, M. O.
philippinensis Ashmead M. O.
Pseudapanteles agilis Ashmead; M. O.

Subfamily XIV. OPIINÆ.

Eurytenes nanus Ashmead, M. O.
Opius eurytenoides Ashmead; M. O.
deceptor Ashmead; M. O.
philippinensis Ashmead; M. O.
Biosteres longicaudatus Ashmead; M. O.

Subfamily BRACONINÆ.

Tribe II. *Braconini.*

Bracon alguéi Ashmead; M. O.
banksi Ashmead; Banks.
ricinicola Ashmead; M. O.
trisignatus Kirby.
vau Ashmead; M. O.

Microbracon luteipes Ashmead; M. O.
Habrobracon rugosiventris Ashmead; M. O.
Iphiaulax deceptor Smith.
luteifrons Brullé.
nigifrons Brullé.
Hemiglypus flavus Ashmead; M. O.

Tribe III. *Euurobraconini.*

Brownius armatus Ashmead; M. O.

Subfamily XVI. Rhogadinæ.

Tribe II. *Rhyssalini.*

Rhyssalus unicolor Ashmead; M. O.

Tribe III. *Rhogadini.*

Rhogas melanosoma Ashmead; M. O.
pacificus Ashmead; M. O.

Tribe IV. *Doryctini.*

Ischiogonus philippinensis Ashmead; M. O.

Tribe V *Hecabolini.*

Hecabolus ruficeps Ashmead; M. O.
rufrocinctus Ashmead; M. O.

Subfamily XVII. Spathiinæ.

Tribe I. *Pambolini.*

Monolexis manilensis Ashmead; M. O.

Tribe III. *Spathiini.*

Spathius fuscipennis Ashmead; M. O.
philippinensis Ashmead; M. O.

Family LXXIX. STEPHANIDÆ.

Stephanus coronator Fabricius.
indicus Westwood.
nigricaudatus Sichel.
sulcifrons Schletterer.
tarsatus Schletterer.
unicolor Sichel.

Suborder II. **Phytophaga** Ashmead.

Superfamily IX. Siricoidea.

Family LXX. ORYSSIDÆ.

Oryssus maculipennis Smith.

Family LXXXI. SIRICIDÆ.

Tremex nigricollis Westwood.

Superfamily X. Selandriidæ.

Paraselandria imitatrix Ashmead; M. O.
Senoclia albocoerulea Bingham.

SOME OF THE PHILIPPINE HYMENOPTERA BRED IN THE MANILA OBSERVATORY, WITH HOSTS.

1. HYMENOPTERA.

Parasites	Hosts
Sycorytes philippinensis Ashm.	Kradibia brownii Ashm.
Philicrypesis ficicola Ashm.	Kradibia brownii Ashm.
Closterocerus brownii Ashm.	Euplectrus manilae Ashm.
Nesolynx flavipes Ashm.	Microplitis philippinensis Ashm.
Ascodes elasmi Ashm.	Elasmus philippinensis Ashm.

2. DIPTERA.

Anopedias luzonicus Ashm.	Lasioptera sp.
Exoristobia philippinensis Ashm.	Exorista dispar.

3. LEPIDOPTERA.

PARASITES	HOSTS
Chalcis albotibialis Ashm.	Erionota thrax Linn.
Chalcis banksi Ashm.	Ticera castanea Swinhoe.
Chalcis prodeniae Ashm.	Prodenia sp.
Anastatus stantoni Ashm.	Padraona chrisozona Plotz.
Eurytoma manilae Ashm.	Eggs of Attacus atlas Linn.
Taftia prodeniae Ashm.	Prodenia littoralis Boisd.
Ooencyrtus papilionis Ashm.	Eggs of Papilio alphenor Cram.
Coccidencyrtus manilae Ashm.	Plusia eriosoma Doubl.
Exoristobia philippinensis Ashm.	Orgyia postica Walk.
Euplectrus manilae Ashm.	Papilio alphenor Cram.
Euplectrus philippinensis Ashm.	Eucleid sp.
Charops longiventris Ashm.	Papilio rumanzovia Esch.
Charops papilionis Ashm.	Papilio agamemnon Linn.
Meteorus brownii Ashm.	Noctuid sp.
Apanteles philippinensis Ashm.	Plusia eriosoma Doubl.
Apanteles stantoni Ashm.	Pieris ida Cram.
Urogaster philippinensis Ashm.	Parasa lorquinii Reak.
Urogaster stantoni Ashm.	Tortricid sp.
Microplitis manilae Ashm.	Prodenia littoralis Boisd.
Microplitis philippinensis Ashm.	Melopsilus acteus Cram.
	Chaerocampa oldenlandiae Fab.
Rhyssalus unicolor Ashm.	Tineid sp.

4. HEMIPTERA.

Hadronotus philippinensis Ashm.	Eggs of Leptoglossus membranaceus Fabr.
Telenomus catacantha Ashm.	Catacanthus cerrenoi Le Guillou.
Aspidiotiphagus aleyrodis Ashm.	Aleyrodes sp.

NOTES ON BIRDS COLLECTED IN MINDORO AND IN SMALL ADJACENT ISLANDS.

By RICHARD C. McGREGOR.

(From the Zoological Section of the Biological Laboratory, Bureau of Science.

I am indebted to Dr. E. H. Porter, contract surgeon, United States Army, for permission to publish the following lists of birds which are based upon collections made by him in the vicinity of Bulalacao, Mindoro, and on the small Islands of Sibay, Caluya, Libagao, and Semirara, off the southeast coast of Mindoro. A few species are recorded from Tambaron, but as this island is very small and but 5 miles off the coast of Mindoro near Bulalacao, it does not seem necessary to deal with it separately.

Dr. Porter was stationed at Bulalacao from May 19, 1905, to February 24, 1906, and most of his specimens were obtained in the vicinity of that town. No visits were made to the higher mountains of Mindoro and information concerning the birds of the smaller islands was gained during short visits to them.

The collection contains specimens of all the species hereinafter recorded in the list of species collected and all of the new records for Mindoro are based upon skins examined by me. For the lists of species from the small islands (Semirara, Caluya, Sibay, Libagao) I have, in most instances, depended upon the field identification made by Dr. Porter, as these species can be easily named on sight.

The ultimate destination of this collection is not known to me, but as Dr. Porter has taken it to the United States it will probably find its way into some one of the larger museums in that country.

The Hand-List, referred to in the text and footnotes, is that by McGregor and Worcester,[1] issued January, 1906.

The sequence of genera and the nomenclature of the present paper are the same as in that publication.

Dr. Porter obtained specimens of thirteen species not hitherto recorded from Mindoro; their points of interest are mentioned in the list of species collected.

[1] *Publications of the Bureau of Government Laboratories* (now Bureau of Science), 36.

LIST OF SPECIES NEW TO MINDORO.

Rallina fasciata.
Sterna borealis.
Ochthodromus mongolus.
Ægialitis peroni.
Totanus eurhinus.
Ardea sumatrana.
Egretta garzetta.
Spizaëtus philippensis.
Hirundo striolata.
Oreocichla varia.
Locustella fasciolata.
Munia cabanisi.
Uroloncha everetti.

On Semirara [2] two species were seen, viz:

Cacomantis merulinus.
Cinnyris jugularis.

For the Island of Caluya Dr. Porter furnishes a list of twenty-two species; of the most interesting bird, *Zosterops*, but a single specimen was killed.

LIST OF SPECIES NOTED ON CALUYA.

Streptopelia dussumieri.
Sterna borealis.
Nycticorax manillensis.
Tanygnathus lucionensis.
Halcyon gularis.
Halcyon chloris.
Cacomantis merulinus.
Eudynamis mindanensis.
Hemichelidon griseisticta.
Hypothymis occipitalis.
Lalage niger.
Pycnonotus goiavier.
Cisticola exilis.
Acanthopneuste borealis.
Artamus leucorhynchus.
Otomela lucionensis.
Zosterops sp.
Cinnyris jugularis.
Oriolus chinensis
Sarcops calvus.
Lamprocorax panayensis.
Corone philippina.

Nine common species were observed on Sibay.

LIST OF SPECIES NOTED ON SIBAY.

Osmotreron axillaris.
Osmotreron vernans.
Halcyon gularis.
Halcyon chloris.
Cacomantis merulinus.
Artamus leucorhynchus.
Otomela lucionensis.
Oriolus chinensis.
Sarcops calvus.

Ten species were seen and identified on Libagao, but the only one of value is unrepresented by skins, so that its identity is open to question.

LIST OF SPECIES NOTED ON LIBAGAO.

Streptopelia dussumieri.
Eurystomus orientalis.
Halcyon gularis.
Halcyon chloris.
Artamides mindorensis?
Pycnonotus goiavier.
Oriolus chinensis.
Sarcops calvus.
Lamprocorax panayensis.
Corone philippina.

[2] For previous lists of birds from Semirara and Sibay, see McGregor, *Publications of the Bureau of Government Laboratories* (1905), **34**, 25–27.

LIST OF SPECIES COLLECTED.

Megapodius cumingi Dillw.
Bulalacao.

Excalfactoria lineata (Scop.).
Bulalacao.

Gallus gallus (Linn.).
Bulalacao.

Turnix fasciata (Temm.).
One female from Bulalacao, May, 1905.

Osmotreron axillaris (Bp.).
From Bulalacao and Sibay; the latter locality is a new one for this species.

Osmotreron vernans (Linn.).
Bulalacao and Sibay; the species has not been recorded before from Sibay.

Phapitreron leucotis (Temm.).
Bulalacao.

Leucotreron leclancheri (Bp.).
A specimen from Bulalacao, where the species is rare.

Muscadivora ænea (Linn.).
Abundant at Bulalacao.

Ptilocolpa carola (Bp.).
Bulalacao.

Myristicivora bicolor (Scop.).
Bulalacao.

Macropygia tenuirostris (Bp.).
Bulalacao.

Streptopelia dussumieri (Temm.).
Abundant in the vicinity of Bulalacao and observed on the Islands of Caluya and Libagao; this is the first notice of the species on these two small islands.

Chalcophaps indica Gould.
Not uncommon near Bulalacao.

Hypotænidia striata (Linn.).
At Bulalacao an adult female of this rail was taken December 7, and an immature female was taken December 22, 1905.

Rallina fasciata (Raffl.).
A male of this rail, taken in May, 1905, near Bulalacao, makes an addition to the list of Mindoro species.

Rallina euryzonoides (Lafr.).
A female specimen from Bulalacao, May, 1905, is similar to one of the same sex from Cagayancillo, except that the tarsi and wings are longer.

Poliolimnas cinereus (Vieill).
A male was taken at Bulalacao, January 19, 1906.

Sterna boreotis (Bangs).
This tern was common at Bulalacao where specimens were collected; it was also observed about Caluya and the small Island of Tambaron. The species seems to be unrecorded from both Mindoro and Caluya.

Ochthodromus geoffroyi (Wagl.).
A male from Bulalacao, October 30, 1905, and a male from Tambaron, January, 1906; small shore birds were particularly abundant along the beach on Tambaron.

Ochthodromus mongolus (Pall.).

A female was taken on Tambaron, January 28, 1906; the species has not been previously recorded from Mindoro.

Ægialitis peroni (Bp.).

A female in winter plumage was taken on Tambaron, January 28, 1906; this is the first time the species has been noted for Mindoro.

Totanus eurhinus (Oberh.).

The redshank is now recorded from Mindoro for the first time on the strength of a male taken at Bulalacao November 29, 1905.

Actitis hypoleucus (Linn.).

A female from Bulalacao, January 25, 1906.

Ardea sumatrana Raffl.

A large heron in immature plumage, taken at Bulalacao, appears to belong to this species, which has been recorded in the Philippines from Palawan and Negros. The present specimen yields the following measurements: Culmen, 6.5 inches; tarsus, 6.5; tail, 7.6.

Egretta garzetta (Linn.).

A male was taken near Bulalacao, January 1, 1906; I have seen birds, probably of this species, near Calapan, but the present specimen seems to be the first to be recorded from Mindoro.

Nycticorax manillensis Vig.

Two specimens of the Manila night heron were taken on Caluya, from which island it was not previously known, December 10, 1905.

Butorides javanica (Horsf.).

Bulalacao.

Ardetta cinnamomea (Gm.).

Bulalacao.

Anhinga melanogaster (Pennant).

Common near Bulalacao.

Sula sula (Linn.).

An adult female of the common booby was taken on board ship some 300 miles from San Bernardino Straits; approximate position, 15° north, 130° east.

Accipiter manillensis (Meyen).

A small *Accipiter* from Bulalacao is most probably of the above species.

Spizaëtus philippensis Gurney.

One adult from Bulalacao; not previously recorded from Mindoro.

Spilornis holospilus (Vig.).

Bulalacao.

Butastur indicus (Gm.).

Bulalacao.

Haliaëtus leucogaster (Gm.).

One adult bird from Bulalacao; another bird of about the same size is doubtfully identified as the young of this species; its tail, however, is much longer than in adult *H. leucogaster*.

Haliastur intermedius Gurney.

Bulalacao.

Elanus hypoleucus Gould.

One specimen from Bulalacao.

Microhierax erythrogenys (Vig.).

Two specimens from Bulalacao.

Cerchneis.?

A specimen of a hawk, possibly a *Cerchneis*, was collected in Mindoro by Dr. Porter. From the literature at hand, I have been unable to identify it and must leave its name to be recorded in a future paper.

Ninox mindorensis Grant.

Two males and a female from Bulalacao do not differ from specimens collected by me on the Rio Bacó, Mindoro; two are in the light phase and the third is lightly washed with rufous on the under parts. Dr. Porter found the species common in the vicinity of Bulalacao.

Prioniturus mindorensis Steere

Bulalacao.

Tanygnathus lucionensis (Linn.).

Bulalacao in Mindoro and Caluya; the latter island is a new locality for this species.

Loriculus mindorensis Steere.

Bulalacao.

Eurystomus orientalis (Linn.).

Bulalacao; the species was also seen on Libagao, which is a new locality for it.

Pelargopsis gouldi Sharpe.

Bulalacao.

Alcedo bengalensis Briss.

Bulalacao.

Halcyon gularis (Kuhl).

Halcyon chloris (Bodd)

These two common kingfishers were obtained at Bulalacao in Mindoro and were also noted on Sibay, Libagao, and Caluya.

Penelopides mindorensis Steere

Bulalacao.

Merops americanus P. L. S. Muller.

Abundant at Bulalacao

Lyncornis macrotis (Vig.).

Several specimens of this fine goatsucker were taken at Bulalacao and one was killed at Pola on the northeast coast of Mindoro.

Caprimulgus griseatus Wald.

Caprimulgus manillensis Wald

Specimens of each of the above species were taken at Bulalacao.

Macropteryx major Hartert.

One specimen from Bulalacao.

Salangana whiteheadi (Grant).

A single female swift from Bulalacao is most probably of this species, but its somewhat bad condition prevents exact determination.

Salangana linchi (Horsf. and Moore).

One specimen from Bulalacao.

Salangana marginata (Salvad.).

Dr. Porter states that this species was abundant at Bulalacao, where he took several specimens.

Hierococcyx fugax (Horsf.).

A male from Bulalacao, taken in May.

Cacomantis merulinus (Scop.).

This common cuckoo was obtained at Bulalacao and was also noted on the Islands of Caluya, Sibay, and Semirara.

Chacococcyx xanthorhynchus (Horsf.).

One specimen from Bulalacao.

Eudynamis mindanensis (Linn.).

A female was taken on Caluya, December 10, 1905.

Centropus mindorensis Steere.

A female cuckoo, probably of this species, taken at Bulalacao, May 18, 1905, has the entire plumage creamy-white, the crown a trifle dusky. Dr. Porter tells me that when collecting in the Camarines Provinces, Luzon, in 1902 he took another white cuckoo.

Centropus javanicus (Dumont).

Bulalacao.

Xantholæma hæmatocephalum (P. L. S. Müller).

A young bird from Bulalacao, taken in May.

Yungipicus validirostris (Blyth).

Bulalacao.

Thriponax mindorensis Steere.

Three specimens were obtained at Bulalacao.

Pitta erythrogaster Temm.

Pitta atricapilla Less.

These two common ground-thrushes were obtained at Bulalacao.

Hirundo javanica Sparrm.

One male from Bulalacao.

Hirundo striolata (Boie).

A young male from Bulalacao taken October 26 is exactly like a young bird taken by me in Calayan, November 1, 1903. This is the first record of the species for Mindoro.

Hemichelidon griseisticta (Swinh.).

A female was taken on Caluya, December 10.

Cyornis philippinensis Sharpe.

Bulalacao.

Hypothymis occipitalis (Vig.).

Specimens from Bulalacao; the species was also observed on Caluya.

Rhipidura nigritorquis Vig.

Bulalacao.

Artamides mindorensis Steere.

Specimens from Bulalacao; Dr. Porter saw birds on Libagao which were probably of this species.

Pericrocotus cinereus Lafr.

One specimen of this migratory minivet was taken at Bulalacao, November 7.

Lalage niger (Forster).

This species was obtained at Bulalacao and observed on the Island of Caluya.

Iole mindorensis Steere.

Bulalacao.

Pycnonotus goiavier (Scop.).

Bulalacao; also observed on Libagao and Caluya.

Oreocichla varia (Pall.).

A male of White's thrush was obtained at Bulalacao, December 7, 1905. This is the most interesting bird in the present collection, as the only previous Philippine specimens are those noted by Tweeddale[3] from "the vicinity of Manilla" and those collected by Whitehead in Lepanto, Luzon, at 6,000 to 8,000 feet elevation.[4]

Petrophila manilla Bodd.

Bulalacao.

Calliope calliope (Pall.).

One specimen from Bulalacao, January 1, 1906; one other was seen.

Copsychus mindanensis (Gm.).

Taken at Bulalacao and on the little Island of Tambaron.

Pratincola caprata (Linn.).

Rare at Bulalacao, where one specimen was killed.

Locustella fasciolata (Gray).

A male in yellowish plumage was taken at Bulalacao, October 15; although the specimen is in poor condition, having been badly shot, I have no hesitation in referring it to the above species which is now recorded from Mindoro for the first time.

Cisticola exilis (Vig. and Horsf.).

Specimens were taken at Bulalacao and the species was seen on Caluya.

Acanthopneuste borealis (Blas.).

Several specimens of this common migrant taken at Bulalacao in November; it was also seen on Caluya and Tambaron.

Artamus leucorhynchus (Linn.).

This swallow-shrike was obtained at Bulalacao and was seen on Sibay and Caluya.

Cephalophoneus nasutus (Scop.).

A male specimen of this shrike was taken at Bulalacao, February 2.

Otomela lucionensis (Linn.).

Taken at Bulalacao; also seen on Sibay and Caluya.

Zosterops sp.

A single female *Zosterops* taken on Caluya, December 10, 1905, can not be determined from the material at hand; it is closely related to *Z. richmondi* of Cagayancillo as well as to *Z. aureiloris* of Luzon and Mindoro.

Dicæum papuense (Gmel.).

Bulalacao.

Prionochilus inexpectatus Hartert.

One specimen from Bulalacao.

Piprisoma æruginosum (B. & W.).

Six specimens were taken near Bulalacao.

Cinnyris jugularis (Linn.).

A young male was taken on Caluya and adults were taken at Bulalacao; the species was also seen on Semirara.

Motacilla melanope Pall.

Budytes leucostriatus Hom.

These two wagtails were killed at Bulalacao.

[3] *P. Z. S.* (1878), 429. [4] *Ibis* (1899), 5, 212.

Anthus rufulus Vieill.

Bulalacao.

Anthus gustavi Swinh.

A male from Bulalacao, October 21.

Munia jagori Martens.

A young female from Bulalacao, October 7.

Munia cabanisi Sharpe.

In a young bird taken at Bulalacao, January 20, the under parts are light drab brown, a few feathers on the flanks and under tail coverts with the characteristic markings of the adult plumage; upper parts earthy brown; edges of rectrices washed with green. A young male of January 10 is somewhat similar in color and has indications of the reddish-brown chin patch. This species is an addition to the list of Mindoro birds.

Uroloncha everetti (Tweedd.).

This is another species of weaver finch added to the Mindoro list by Dr Porter, who took a specimen at Bulalacao on December 10.

Oriolus chinensis Linn.

Obtained at Bulalacao and seen on Caluya, Libagao, and Sibay

Dicrurus balicassius (Linn.).

Bulalacao.

Sturnia philippensis (Forster).

Specimen collected in the vicinity of Bulalacao.

Sarcops calvus Linn.

Collected at Bulalacao and seen on Caluya, Libagao, and Sibay.

Lamprocorax panayensis (Scop.).

Abundant at Bulalacao; also noted on Caluya and Libagao.

Corone philippina (Bonap.).

Numerous specimens from Bulalacao; also seen on Caluya and Libagao.

Corvus pusillus Tweedd.

A number of specimens taken at Bulalacao

REVIEWS.

The Practice of Medicine. A text book for practitioners and students with special reference to diagnosis and treatment. By James Tyson, M. D. Fourth edition, revised and enlarged, with 240 illustrations, including colored plates. Cl., pp. 1305. Price, $5.50 net. Philadelphia: P. Blakiston's Son & Co. 1906.

On the whole Dr. Tyson has given us a splendid book and the value of this last addition is much enhanced by Dr. Smith's excellent chapter on animal parasites and the conditions caused by them.

Diabetes, typhoid fever and a number of other diseases of which the author has long been known as a careful student have received a most thorough and satisfying consideration.

All discussions as to treatment are carefully revised and thorough; the positiveness with which drugs are recommended and the careful details for their administration will do much to retain fast-disappearing optimism in this branch of therapeutics.

One is somewhat surprised that the paratyphoid fevers should receive such brief consideration and the discussion of some other diseases such as Malta fever, amebic dysentery, dengue, and even malaria, is hardly satisfying, at least to those working with these infections in the Tropics.

It would seem that the recent literature on smallpox, splenic anemia, splenomegalies in general, arterioschlerosis, and several other diseases is of sufficient importance to give more of it attention in a book of this character, revised as it is to 1906.

W. E. M.

Nothnagel's Encyclopedia of Practical Medicine: Malaria, Influenza, and Dengue. By Dr. Julius Mannaberg and Dr. O. Leichtenstern. Edited with additions by Major Ronald Ross, F. R. C. S., F. R. S., C. B.; J. W. W. Stephens, M. D., D. P. H., and Albert S. Grünbaum, M. D., F. R. C. P. Translated from the German under the editorial supervision of Alfred Stangel, M. D. –Cl., pp. 769. W. B. Saunders & Company, Philadelphia and London, 1905

The volume of Nothnagel's Practice dealing with malaria, influenza, and dengue, is of peculiar interest to the student of tropical medicine by reason of the wide distribution and importance of the first of the diseases treated and because of the uncertainty of the nature and symptomatology of that disease so exclusively diagnosed in the Tropics, namely, dengue.

In connection with the section on the etiology of malaria it is observed, under the head of methods of examination, that after giving in detail steps for making unstained preparations, the statement is made that if by reason of not having a microscope at hand or for any other cause it is deemed advisable, dry preparations may be made and stained. This attitude in almost all text-books on the subject of malaria, which would appear to advocate the choosing of either the stained or unstained preparation, is unfortunate—it is as if two rival methods were presented and a choice had to be made between them. In distinguishing the different kinds of parasites, there is so much to be learned from a study of both unstained and stained specimens that it would seem advisable strongly to impress upon everyone who takes up the subject to employ both methods. While waiting for the completion of the staining, the observer has a few minutes which can profitably and without loss of time be devoted to the fresh blood and then later, the stained smear can be studied with greater facility by reason of the information gained from the unstained preparation. Especially as regards differentiating young forms, there would seem to be no question as to the advantage of the stained over the unstained preparation.

The Romanowsky-Zieman stain is greatly praised by the editor and it is certainly most excellent. However, it has the same objection which obtains to the well-known Leishman and Wright stains, of not keeping well in the Tropics. When polychroming is done by precipitating silver nitrate, as in Borrel's blue, a much more permanent stain for the Tropics is made than is the case where sodium carbonate or bicarbonate is employed.

In view of the general tendency among those capable of speaking authoritatively, to consider simply three forms of malaria, it would appear unfortunate that in a work so influential it was deemed advisable to multiply the different species. The propriety of dividing the parasites, the sexual form of which is manifested in crescents, into three classes is certainly questionable and it is at least an unfortunate complication for the novice in the study of malaria.

In the excellent chapter on malaria in its relation to the mosquito, in the paragraph on differentiation of species will be found a concise and comprehensive consideration of the points to be observed in examining *Anophelinæ* and the confusion which may arise from attributing too much importance to spots or attaching weight to the position of the cross veins is clearly indicated.

Under the genus ***Myzomyia*** the same view is adopted as is given in Theobald's monograph, namely, that ***M. ludlowii*** Theob., is probably not a distinct species, but only a variety of ***M. rossii*** Giles. An examination of a large number of this common malarial mosquito of the Philippines shows the constant presence of the characteristics presented by ***M. ludlowii*** Theob., and its difference from ***M. rossii*** Giles so that it would appear to

have greater claim to the distinction of a separate species than is the case with many other ones of *Anophelinæ*.

Were it not that we have in the finding of the parasite in the blood a method of diagnosing æstivo-autumnal fever which rarely fails one who has experience, the multiplicity of varying manifestations of this type of malaria, as it is discussed in the chapter on perniciousness, would cause one forever to despair of diagnosing pernicious malaria from an endless number of other more or less serious conditions. The article is of value because it shows the possibilities of pernicious malaria, but it certainly is confusing. Again, were quinine given hypodermically immediately after the microscopical diagnosis is made, it is believed that these pernicious types would lose in importance.

In carefully reading over the portion of the book treating of influenza, it is impossible for one familiar with dengue not to be constantly asking himself whether by any possibility these two diseases may not be identical. It is an easy matter in the comparatively mild cases of dengue, where the eruption is abundant and after a typical differential count of the white blood corpuscles, to feel reasonably sure that we are dealing with a separate disease, but when we have in mind those cases, usually considered as dengue, where the nervous manifestations are most pronounced—particularly the intense depression—and where the eruption and the count of the leucocytes have little which is characteristic, it would seem to be only a distinction in name between this form of dengue and influenza. Consequently, viewed in this light, the three-page table of epidemiological and clinical differences between influenza and dengue would appear to be superfluous.

E. R. S.

THE PHILIPPINE

JOURNAL OF SCIENCE

Vol. I SEPTEMBER, 1906 No. 7

STUDIES IN BERIBERI.

By Maximilian Herzog.

(*From the Biological Laboratory, Bureau of Science.*)

INTRODUCTION.

The investigation of the many unsolved problems in beriberi, both in regard to the character and the special and general features of the disease, presents many profound difficulties. Almost all modern writers have called attention to this fact. For instance, Wright,[1] in the introduction to his recent monograph on beriberi, says:

> Probably there is no disease whose etiology is so much a matter of speculation as that of beriberi. Certainly there is no disease whose literature when read leaves one in so great a state of mental confusion. Nitrogen starvation, pernicious anæmia, infected fish and raw fish diet, arsenical, carbon dioxide, and miasmatic intoxication, bacterial and plasmodial infection are amongst the many direct causes put forward to account for it. They are largely speculative or founded on superficial or one-sided observation. No one of them is generally accepted. Many of them may and ought to be excluded as chief pathogenic factors.

Durham,[2] who succeeded Wright as an investigator of beriberi in the Malay Peninsula, and who came to conclusions materially differing from those of his predecessor, likewise emphasizes the great difficulties encountered in the study of this disease, and writes as follows:

> The literature of beriberi is so great and at the same time so divergent, and so contradictory are the views and records that have been given, that I have

[1] Wright: An Inquiry into the Etiology and Pathology of Beriberi. *Publications of the Federated Malay States*, Singapore (1902), May.

[2] Durham, Herbert E.: Notes on Berberi in the Malay Peninsula and on Christmas Island. *Journal of Hygiene* (1904), 4, 112.

excluded it as far as possible from these notes. When the day of complete knowledge of the nature of beriberi shall arrive, it must assuredly happen that many of the hitherto published records will disappear, from their failure to mention the circumstances which attend the real cause.

The present writer, after having investigated a number of cases of beriberi both from a clinical and pathological standpoint, occurring in Manila between February, 1904, and August, 1905, was directed during the latter month to proceed to Japan for the purpose of studying the large amount of *kakke* material which had accumulated in the military hospitals of Hiroshima and Tokyo during the late Russo-Japanese war. A brief preliminary report concerning these studies has already been published in this journal.[3] In the discussion which follows it is the intention to present to the practitioner who may be called upon to diagnosticate and to treat cases of beriberi, a systematic general outline of the affection, and at the same time there has been included an account of the investigations which have been carried on with the view of finding the specific micro-organism which causes this disease and of confirming or denying the recent claim of Okata and Kokubo concerning the discovery of the causative factor of the malady. A detailed summary of the first Japanese publication on the Okata-Kokubo kakke coccus was given in my preliminary report. These Japanese army surgeons have published a number of further contributions since this publication appeared and have reaffirmed their statements as to the specific nature of their coccus. However, we can not confirm their claims, since we find that this organism certainly is not the etiological factor in beriberi. In fact, none of the bacteria and other micro-organisms from time to time proposed as being the cause of this mysterious disease can be considered to be specific. I have not, for obvious reasons, given a lengthy review of the literature of beriberi. The greater part of it to-day is merely of historical interest.

DEFINITION.

Beriberi—*Polyneuritis endemica* (Baelz), *Neuritis multiplex endemica* (Scheube)—may be defined as an acute, subacute, or chronic infectious disease, characterized clinically by disturbances of the circulation, of motion and of sensation, and associated anatomically with hypertrophy and degeneration of the heart, of the peripheral nerves, and of the voluntary muscles.[4]

[3] Herzog: Beriberi in the Japanese Army During the Late War. *Phil. Journ. Science*, February (1906), 1, 169.

[4] A complete discussion of the nomenclature is given in Scheube's *Die Krankheiten der warmen Länder* (1903), Jena, and *Die Beriberi-Krankheit* (1894), Jena. These two publications of Scheube include a summary of the literature of beriberi up to 1903, comprising about 700 books, monographs, and other articles.

HISTORY AND GEOGRAPHICAL DISTRIBUTION.

The first undoubted mention of beriberi is made in a Chinese work of the second century of the Christian era, and a good description of the disease is to be found in a Chinese text-book on medicine of the sixth century. It is also possible that the disease may very early have appeared in the Western Hemisphere, because two quotations from Strabo and Dio Cassius, giving a description of a Roman invasion of Arabia in the year 24 B. C., perhaps refer to an epidemic of beriberi among the soldiers of the Roman army.

The disease is now generally prevalent in tropical and subtropical regions in which as a rule the humidity is considerable. It is found in Asia, Japan (including Formosa), China, the Malay Archipelago and Peninsula, the Dutch Possessions, and in Eastern India. It occurs on the eastern coast of South America, particularly in Brazil, and a number of reports of its presence in Africa during the last two decades have appeared.[5] Some isolated epidemics have also taken place in England and Ireland, and sporadic, imported cases have been encountered in Continental Europe, the United States, and Canada. It is also prevalent among the native population throughout the Philippine Islands. During the early days of the American occupation of Manila a few cases occurred among the white troops, but for several years beriberi has certainly been of very rare occurrence among the Americans, the author having only seen two cases during two years. One was in a teacher who had returned to Manila from Mindanao, the other in a physician who for several years had been in charge of the Mindoro prison, which formerly was one of the most notorious foci of beriberi in the Islands, but which was abandoned some time ago.

THE FIRST EPIDEMIC OF BERIBERI IN THE PHILIPPINE ISLANDS.

It is somewhat strange that the records concerning beriberi in these Islands date back only a few decades. Koniger[6] in 1884 reported what he considers the first invasion of the Philippines by beriberi, the epidemic occurring during the year 1882–1883. In view of the fact that the disease has for many centuries been so widespread in Japan, it is hardly credible that the Philippines should have been exempt from it until 1882. Moreover, it is an historical fact that during the constant feudal strife and the civil wars preceding the establishment of the Fogugawa Shogunate many impoverished Japanese frequently were forcibly exported to the Philippine Islands by Portuguese slave traders and sold as slaves. Besides, northern Luzon was once invaded by a Japanese army.[7] It is generally claimed in the Philippine Islands that leprosy

[5] According to A. Plehn it has been observed in the latter country in the following places: Reunion, Mauritius, Nossi-be, Zanzibar, Cope Colony, Senegal, Angola, Congo State, German West Africa (Kamerun).

[6] Königer: Ueber epidemisches Auftreten von Beriberi in Manila, 1882 1883. *Deutsch. Archiv. für Klin. Medizin* (1884), 35, 419.

[7] Griffis: *The Mikado's Empire*, 9th edition, New York (1900), 246 and 254.

was brought to the Archipelago from Japan, and under these circumstances it would be remarkable if beriberi had not been imported into Manila before the date given by Königer. However, the latter author has given us a very interesting report of what he considered to be the first invasion of the Philippine Islands by the disease. His article may be briefly summarized as follows:

"From August to October, 1882, Manila was visited by a severe cholera epidemic, which there found a fertile soil and carried off between 15,000 and 20,000 victims (the population of Manila was estimated at 400,000). A panic occurred among the native as well as among the European population, because cholera had not been present since 1865 and as the mortality was more than 75 per cent. After the epidemic had subsided, on October 20, a terrible typhoon visited the city and province and destroyed all the suburban houses built of light material. As a consequence, almost the whole native population of Manila and its surroundings was without shelter. In Manila alone, 60,000 families had lost their homes. Nor was it possible rapidly to rebuild the destroyed houses and huts, since, following the typhoon, a flood occurred and all the lower parts of the city and province were under water for several weeks. Building material was scarce and very expensive. By this time, while the cholera epidemic was still smoldering, a new disease, which killed its victims in a few days or weeks, was noticed among the inhabitants. The native and Spanish physicians did not recognize the malady and the terror of the population increased. In some cases the disease was connected with a swelling of the glands and it therefore was believed by some to be a variety of bubonic plague. As soon as I saw the first cases, I had no doubt that I was dealing with a particularly malignant epidemic of beriberi, of which I had seen some cases in Japan. I caused a notice to be published by the Spanish medical board, explaining that the prevalent disease was not bubonic plague. The epidemic of beriberi rapidly spread in the province of Manila and along the coast to the neighboring territories. It remained stationary during November and December and gradually decreased during January. When I left Manila during the middle of March the epidemic had very much decreased, and there were also still present a number of sporadic cases of cholera."

"Beriberi had heretofore not been known in Manila. Whether the disease had occurred at all at this place during the last three centuries might perhaps be ascertained from a study of the friars' records. However, it was not known to the inhabitants, including the physicians, some of whom had practiced in Manila for more than forty years. I myself, during a practice of three years had never seen a case of beriberi. This first appearance of the disease in Manila is of particular interest because of the enormous mortality observed during the beginning of the epidemic. This mortality is not surpassed by anything heretofore reported and is higher than it is stated to be by almost all other observers. I have no reliable data as to the percentage of beriberi mortality during the first month. There are at present no official figures of value, and if subsequently any should appear they would not deserve any confidence. The general impression existing among physicians as well as laymen during the first part of the epidemic was that the disease was absolutely fatal. However, during the earlier part of the outbreak I saw several cases which recovered. Still, I think that a mortality of 60 per cent for the first month is by no means too high an estimate. As to the total number of deaths I have only one reliable observation, according to which during a period of a little more than two months, over 300 deaths from beriberi occurred in Malabon, a place of about 25,000 inhabitants, situated 7 kilometers from Manila. However, it is probable that this place suffered more

than any other in the vicinity. The conclusion certainly appears justified that the number of victims in the capital and the surrounding provinces reached several thousand."

Königer attributes the great mortality which he noticed in this epidemic of beriberi to the distress existing among the natives and to their very poor state of nutrition. Almost all of the cases were seen among the poorer classes, the author observing only two among Europeans, who, however, were also living under very unfavorable conditions. Among the Chinese the number was small as compared with that among the natives.

ETIOLOGY.

It is astonishing and at the same time embarrassing that the etiology of beriberi, a disease so widespread and one which has been the subject of such extensive investigations, is still but little understood, not merely as to its specific cause but also as to other concomitant factors favoring its appearance and spread. Manson,* in a recent article on this subject, expresses his views as follows:

"It is a somewhat humiliating fact that although beriberi is a disease of first-class importance in the Tropics, although it exhibits peculiarities in its epidemiology so striking that they seem to suggest that surely the cause can not be hard to find, and that although not a few investigators, medical and lay, have diligently set themselves to find this cause, they are about as ignorant of its true nature and of the medium in which it is applied and of the other etiologic circumstances as was Bontius when he wrote about beriberi over two hundred and fifty years ago. Quite recently there may have been some advances, but even these recent advances are more in the direction of showing what beriberi is not, rather than in the direction of showing what it is."

Scheube, to whom, as well as to Baelz, we owe so much of our knowledge concerning beriberi, believes that beriberi is an infectious disease and not a disturbance of the functions of nutrition caused by rice, fish, or insufficient nutrition. He points out that frequently strong, well nourished young people suffer from beriberi, that the disease occurs independently of nutrition and other conditions of environment in certain well-defined districts, and that it is particularly prevalent at the seashore and along the banks of large rivers. He believes that the disease is not contagious, but that it may be and is carried along the lines of traffic by railroads and by vessels. He calls attention to the fact of the frequency of beriberi in places where human beings are crowded together, such as in prisons, schools, and factories. He also states that observations have been made in Japan showing clearly that the importation of a few cases of beriberi into a heretofore non-infected district has been followed by larger outbreaks of the disease, a fact which also has been reported by Robert Koch with reference to the introduction of the disease into New Guinea by some laborers coming from a distance. Scheube believes that beriberi is due to a micro-organism, either of a vegetable or of an animal nature, forming a toxin which acts upon the nervous system. He emphasizes the fact that beriberi shows a predilection for certain races, being very common among the Japanese, Chinese, and Malays and rare among the Europeans

*Manson: The Phophylaxis and Treatment of Beriberi. *Brit. Med. Journ.* (1902), 2, 830.

and Americans living in the East. It is more common among males than among females and it generally attacks individuals under 30 years of age.

Manson's theory as to the origin of beriberi is that the disease is a neuritis caused by a toxin, the latter being the product of a germ operating in some culture medium located outside of the human body. He believes that this toxin does not enter the body in food or in water but is inhaled or introduced through the skin.

Takagi, late surgeon-general of the Japanese navy, still adheres to the theory that *kakke* is due to an insufficient diet, particularly to one containing a large amount of rice. When he first studied the question of the etiology of beriberi, the ratio of beriberi patients in the Japanese naval force in 1883 was 231 per thousand. After the diet was changed, the number of *kakke* patients in this branch of the Japanese service diminished, so that in 1898 the ratio was only 0.87 per thousand. However, it has frequently been pointed out that during this period of time the number of *kakke* patients in Japan had also greatly diminished in districts and among bodies of men where such a radical change of diet had not taken place.

Experiments on several hundred prisoners in the Malay Peninsula during a period of eleven months furnished conclusive proof to Wright that beriberi was contracted, even though the diet was qualitatively and quantitatively correct. He thinks that his experiments positively eliminate diet, as such, as a factor in the causation of the disease.

Durham was struck by the fact that the well-to-do in and about the Federated Malay States escaped the disease, whereas people who were in poor surroundings were stricken, so that it was difficult not to believe that some food constituent, when sufficient in amount, protected the nervous system. However, he also noticed that beriberi may spread through a community in which the inhabitants are taking a sufficiently nitrogenous diet, and in proof of this he cites the instance of the prisoners in the gaol of the Federated Malay States. In spite of all, he thinks it is difficult, if not impossible, not to believe that the character of the food and the occurrence of beriberi are in some way related. Many of the published records seem to indicate such a connection, although the records of the Puda gaol show that the old theory of nitrogen starvation can not be upheld.

Stanley (l. c.) remarks that in Shanghai, China, beriberi as a rule becomes prevalent toward the end of the summer. He saw 500 cases among the Chinese prisoners in the municipal gaol and in three police stations from 1898 until 1902. Most of these occurred among the long-term prisoners, in spite of the fact that they lived under better conditions as regards ventilation, cleanliness, exercise, and food than they did prior to their incarceration. Beriberi among the better classes of the general population is rare in Shanghai. Stanley declares that he is unable to answer the question why beriberi should be so much more prevalent among the municipal prisoners than it is among the general Chinese population of the city.

Sambon [a] thinks that an enormous amount of evidence has been brought forward against the belief that rice diet is a direct causative factor in beriberi; however, this diet may be related to beriberi just as we now understand the consumption of maize to be related to pellagra; but nevertheless, he believes that the specific agent of beriberi lives within the patient's body. He finds the prevalence of the disease to be increased by a high temperature and an abundant rainfall, and recalls that it is chiefly an affection of the common laborer, that we are absolutely ignorant of the manner in which it is carried from place to place.

[a] Sambon: A Discussion on Beriberi. *Brit. Med. Journ.* (1902), 2, 835.

and that, whatever might be the cause of the malady, we can not deny that diet seems to have a potent influence on its frequency.

Two Japanese investigators, Terauchi and Saiki,[10] have carried on some chemical investigations on a beriberi case which showed œdema, paralysis, hypæsthesia and other disturbances of motion and sensation. They found no interference with the digestion and absortion of nitrogenous food, but demonstrated that the nitrogen excretion in the urine was much increased, the amount being in excess of the nitrogen ingested. An increase in the amount of nitrogenous food taken into the system was followed by a proportionate rise in the amount of excreted nitrogen. These results are in opposition to some statements of Scheube and Durham, according to whom proteid metabolism in *kakke* patients is diminished. Careful urine analyses carried on in 43 cases of beriberi failed to show either albumen or sugar.

Duerck[11] has recently studied beriberi in Sumatra, and his histologic investigations confirm the description of the profound changes in the peripheral nerves and the skeletal muscles previously recorded by other writers. He advances the following hypothesis as to the cause of these lesions:

"The ubiquitous character of the degenerative lesions in the peripheral nerves and muscles and the absence of such changes in other organs compels one peremptorily to conclude that the harmful agent, acting in so specific a manner, can not be a living organism either of a vegetable or of an animal type. One can not, of course, exclude the possibility that the non-vital poison may enter the body, perhaps through the intestinal tract by the aid of a micro-parasite. However, if this be so, the absence of an obvious primary lesion or primary reaction is very striking. Lesions of the peripheral nerves caused by toxic substances are, of course, frequent. In this connection we may mention degenerations and inflammatory lesions due to alcohol, lead, arsenic, carbon bisulphide, ergotin, and other intoxicants, and it is also well known that substances formed in the body itself may, by processess of autointoxication, lead to lesions of the peripheral nerves."

Yamagiwa[12] has recently reaffirmed his former statements regarding the etiology of the disease in the following words: "Kakke or beriberi is an intoxication due to the daily use of boiled rice which has been improperly stored and preserved. The intoxication causes a contraction of the small arterial branches of the circulation. This again produces dilatation and hypertrophy of the heart, local anæmia of the skin, mucous membranes, peripheral nerves, muscles, and kidneys, and finally regressive metamorphoses in the tissues named."

Wright, in giving a summary of the theories regarding the etiology of the disease, mentions the following: (1) Gelbke's theory that beriberi is due to dry fish infected with a trichina, (2) that of M. Miura that it is due to the ingestion of certain kinds of raw fish; (3) Grimm's theory that it is caused by the ingestion of infected fish; (4) Takagi's that it is due to a pathogenic diet in which nitrogen is deficient; (5) Ross's that it is the result of arsenical poisoning; (6) the belief that it is due to the ingestion of moldy rice; (7) Braddon's theory that the ingestion of a specific organism which develops on growing rice causes beriberi; (8) Manson's that it is due to a place germ, and (9) Glogner's that it is produced by a hæmic plasmodium.

[10] These investigations have not been published. I am indebted to Professor Shiga, of the Tokyo Institute for Infectious Diseases, where they were carried on, for a communication concerning their result.

[11] Duerck: Ueber Beriberi, etc. *Münch. Mediz. Wochenschrift.* (1905). **52**, 1913.

[12] Yamagiwa (and Yamanowchi): Ueber das wesen der Kakke. *Salkowski Festschrift, Virchow's Archiv.*, **156**, 451.

Views other than the above in regard to the etiology of beriberi are that it is an anæmia of a pernicious type, that it is a modified and secondarily changed form of scorbutus, that it is due to carbon monoxide poisoning, or that it is caused by *Uncinaria duodenale* or by *Trichocephalus dispar*.

The following list gives the names of a number of investigators who have laid claim to the discovery of the specific micro-organism of beriberi: DeLacerda (a bacillus), Taylor (a bacillus), Rost (a bacillus), Ogata (a bacillus), Van Eecke (a coccus), Pekelharing and Winkler (a bacillus and a coccus), Wright (a coccus), Dangerfield (a coccus), Glogner (an amœba), Fajardo (a hæmatozoön), and Okata and Kokubo (a coccus).

Wright, in his studies on beriberi in the Malay Peninsula, noticed that although the disease is almost unknown among Europeans, a few authenticated cases had been reported during the last ten years. In the Malay Peninsula the disease occurs mainly among the Malays, Tamils, and particularly the Chinese, and the greatest number of cases is found in the prisons. This author's theory in regard to the etiology of beriberi is that it is due to a specific organism which gains entrance to the body by the mouth, develops chiefly in the pyloric end of the stomach and the duodenum, and produces a toxin, and that the latter being absorbed, causes atrophy of the peripheral terminations of the afferent and efferents neurons. He further believes that the specific organism is passed in the fæces and then lodges in the floors and walls of confined places through accident or through the careless personal habits of those affected by the disorder; whereupon, provided congenial meteorologic, climatic, and artificial conditions exist or there is close association from overcrowding, the organism becomes virulent and, gaining entrance to the healthy body by means of food, gives rise to an attack of the disease. Wright explains the fact that the germ remains so closely focal by its being at once destroyed by the action of direct sunlight; he also assumes that the presence of carbon dioxide or some other gas is necessary for its development in a virulent state. It seemed to him that the duration of the active stage of the organism in the body is between three and four weeks. He examined blood taken from 12 acute pernicious beriberi cases, from 36 simple acute ones, and from 27 in which a residual paralysis was existent, in order to detect the specific organism of the disease, if possible. The blood was first collected from the skin of the finger and lobe of the ear, and if a growth occurred in the culture media a second specimen was taken from the median cephalic vein at the elbow. The blood of 18 Chinese not infected with beriberi was examined by identical methods for control experiments. Wright concluded that the few organisms which developed in the cultures in these two series of investigations were contaminations derived from the skin and that they have no relation whatever to beriberi. Some of these organisms, Wright states, had previously been described by Pekelharing and Winkler and by Von Eecke, who had erroneously believed that they were associated with beriberi. It is interesting to quote freely from Pekelharing and Winkler, who have claimed to have discovered the specific cause of beriberi. They say: "In 15 cases we obtained a growth of bacteria; from 12 patients a growth of micrococci; from 3, one of rod-like bodies. The rods differed from each other in every instance. * * *

"In the 12 other cases the tubes inoculated with blood showed micrococci. These developed best on the solid substances, where they formed a white bed with a shining surface. This phenomenon was noticed in 10 cases but in 2 of the cultures a yellow color developed. * * * Sometimes different bacteria were cultivated from the same blood but this did not happen when agar-agar and blood serum were used as the media. * * * The different colonies which developed on the bed of gelatine did not at all resemble each other. On one occasion we found seven colonies of micrococci, of which two consisted of a white and five of a yellow

growth. * * * On several occasions we also noticed that, when we placed a little of the old, white growth of micrococci which had been kept for some months in a fresh soil of agar-agar, yellow growths of micrococci were developed which sometimes grouped themselves in tetrad forms. But we can not draw hasty conclusions from any of these observations. * * * Some further researches will be necessary to decide whether the different forms of micrococci which we obtained in our attempts at cultivation from the blood of sufferers from beriberi are of different species, or whether they are not varieties of the same one. Objections may be advanced that in these fifteen cases the bacteria did not occur in the blood, but that they were collected by an accidental contamination during manipulation and so entered the nutrient media."

It may be added that all of the animal experiments of the Dutch investigators were entirely inconclusive in character.

Stanley[13] examined the blood in 30 cases of beriberi occurring in Shanghai. In each instance 1 cubic centimeter of blood was collected under aseptic precautions from the median cephalic vein, and inoculated into various culture media. In all, 150 cultures were made. All the tubes excepting two remained sterile. These developed *Staphylococcus pyogenes aureus* and *Micrococcus tetragenus.* He also injected 1 cubic centimeter of blood from beriberi cases into each of six rabbits. These animal experiments and others in which moldy rice was employed were completely negative. Stanley concludes that the blood in beriberi is sterile and that the organisms found by Pekelharing and Winkler do not stand in any causal relationship to the disease. His experiments carried on with the object of detecting whether a specific toxin was present in the rice were likewise negative.

Ellis,[14] who had an opportunity in the government lunatic asylum of Singapore, of studying a large amount of beriberi, made a number of blood examinations in order to verify Pekelharing and Winkler's claims. However, he completely failed to find a bacillus in the blood, and his cultures made from the spleen, stomach, nerves, and other organs at post-mortem examinations likewise were negative.

Glogner,[15] whose work on beriberi is frequently mentioned, says that the disease is simply a multiple neuritis which is very common under tropical conditions, but which also occurs in Europe. He calls attention to the fact that whereas in Europe, when the symptoms occur in connection with diphtheria, typhoid, lead or alcohol poisoning, the etiology is generally obvious, in the Tropics the origin of the malady is as a rule not easily detected. This author examined the blood from the spleen of 98 cases of beriberi. He claims that in 63 he found extraglobular bodies rich in pigment, which were different from the hæmaœba of malaria. Glogner regards these bodies to be the specific cause of beriberi.

Fajardo[16] has claimed the discovery of another protozoön in the blood of beriberi patients which is very similar but not identical with the malarial parasite. He also regards this organism as the specific cause of the disease.

Rost[17] observed an outbreak of beriberi in the Meeklita gaol, India, and which occurred at about the same time that a disease attacked pigeons in the vicinity

[13] Stanley: The Nature of Beriberi. *Journal of Hygiene* (1902), **5**, 369.

[14] Ellis: A Contribution to the Pathology of Beriberi. *London Lancet* (1898), **2**, 985.

[15] Glogner: Ein weiterer Beitrag zur Aetiol. der mult. Neuritis in den Tropen. *Virchow's Archiv.* (1895), **141**, 401.

[16] Fajardo: Von der Haematozoarie der Beriberi und deren Pigment. *Centralbl. für Bacteriol.* (1898), 1 Abt., **24**, 558.

[17] Rost: The Cause of Beriberi. *Brit. Med. Journ.* (1902), **2**, 835.

and caused paralysis of the wings and death among these birds. He believes the cause of beriberi to be an angular diplobacillus, which is extremely resistant to heat, a temperature of 220° F. acting for nine hours being necessary to kill the spores. He claims to have found this same organism in the blood and in the cerebro-spinal fluid of a large number of beriberi cases. From blood, it could be cultivated in broth, rice broth, and in ascitic fluid. It was very motile and about the size of the tubercle bacillus. The organism was found in moldy rice as well as in the blood of beriberi patients. He believes that with it he could produce in fowls, both by feeding and inhalation, a disease exactly similar to beriberi in man.

Durham performed a number of experiments with the view of producing in monkeys, guinea pigs, and rabbits a disease similar to or identical with beriberi. His experiments included the feeding of dry fish and rice, injection of serum from beriberi cases, the administration by the mouth to monkeys of the contents of the gastro-intestinal tract of beriberi cases, to monkeys of dust from infected localities, inoculation from throat to throat in monkeys, and attempts to infect with bedbug bites. All the experiments were absolutely negative. Durham severely criticises Wright's claim of having produced beriberi in monkeys by confining the animals in prison cells where the disease had constantly been prevalent in man, and by feeding these animals with food mixed with the dust from such cells. He says that the neuritis observed in Wright's monkeys was due to septic absorption from old, chronic ulcers and he further states that he himself observed the nerves in an advanced state of degeneration in monkeys showing septic processes. Durham is inclined to regard the tonsils as the portal of entrance of the specific virus of beriberi, and with reference to this point he says: "Clinical observations of throats in two places, * * * Gopeng Perak and Christmas Islands, more than 1,000 miles apart, as well as in Kuala Lumpur, seem to indicate that in early cases and in those which had recently come to hospital there was a marked faucial redness. This condition was not associated with tenderness or swelling of the lymphatic glands. Sterilized cotton, wood swabs mounted on wires were smeared on the throats of a number of patients and then on the surface of agar media in Petri dishes. After twenty-four hours, or better after forty-eight hours, remarkable numbers of small, low, translucent colonies appeared on the plates. After ninety-six hours they measured only about 1 millimeter in diameter. Under a low power of the microscope they showed a well-marked, distinguishing feature in that there were tiny loops of projecting organisms around the periphery. Some plates were crowded with these small looped colonies, and this almost or quite to the exclusion of other kinds of colonies. Morphologically they assumed a somewhat streptococcal appearance being grouped in short chains but there was a great tendency to the formation of involution forms of a swollen, irregular, or rod-like character; no motility, stained by Gram's method."

However, Durham did not succeed in isolating the same organisms from the dust of the cells, nor did he obtain it from the intestinal tracts of bodies dead of beriberi. His attempts to propagate this organism in the second generation failed. He found no evidence that mosquitoes or cockroaches spread the disease. Durham believes that the dietetic or physiologic theory, the one of unsound food, or of arsenical poisoning all appear to be insufficient to account for the spread of the disease. His own observations prompt him to believe that beriberi is communicated more or less directly as an actual infection from person to person, or through fomites.

Tetamore[18] reports an epidemic among native prisoners in the United States

[18] Tetamore: *Surgeon-General's Report for the Fiscal Year ending June 30, 1901;* Washington (1901), 236.

military prison, Lingayen, Pangasinan, P. I. This outbreak occurred between October, 1900, and January, 1901. There were 141 persons attacked by beriberi, of which 31 died. Bacteriological examination of the blood was made in 35 cases. The results, in general, were negative but in a few cases micrococci were found which were not regarded as specific in their nature.

From the above statements it appears that the most careful attempts to obtain a specific organism from the blood of beriberi cases have been negative. It may also be mentioned that Robert Koch was unsuccessful in isolating any specific bacterium.

Dangerfield[19] has recently published a very elaborate report of 400 pages on beriberi. On page 59 of his book he says: "Since 1897 I have been impressed with the constancy of digestive disturbances in all cases of beriberi, manifesting themselves in the form of anorexia, gastralgia, vomiting, nausea, dyspepsia and epigastric pain on pressure. We have therefore studied this question carefully in the living as well as in the cadaver. Later, we have intubated many patients with Fauche de Beouf's stomach tube, in order to examine the gastric contents. In almost all of our cases we have found cocci, both by the direct microscopical examination and by making cultures in Jensen's fluid, after neutralizing the gastric contents. Therefore, it is this method which one should preferably use in searching for the beriberi coccus in the living. The pathological-anatomical lesions of the gastro-intestinal tract are so characteristic that we have questioned how it could be possible for them to have escaped the attention of other observers. The bacterium of beriberi belongs to the family *Coccaceæ* and to the genus *Micrococcus*. It appears in the form of a spherical, perfectly round, isolated cell. However, this form varies according to the stage of evolution of the bacterium." [20]

Dangerfield states that the organism is found on the epidermis, in the soil, in the air, in water, in the sputum, in vomited matter, and in the fæces, as well as in the intestinal tract, in the stomach, and in the small intestine. Round cells from 0.2 to 1.5 μ. Very unstable in virulence. Grow well at from 22° to 45° C. Do not live at 0° or above 100° C. They are obligate aërobic. Grow rapidly at 37° C. on agar; however, during the first twenty-four hours, slowly. Odor is disagreeable. No evolution of gas. Stain with difficulty by Gram's method. Slowly decolorize by acid alcohol. Give indol reaction in young bouillon cultures. Do not give the cholera red reaction. Culture media are always alkaline in all stages of growth. Bouillon becomes very slightly clouded with a slight film around the edge of the surface. There is formed a milky, non-viscous, white deposit. Grows poorly in glucose bouillon. On Roux plates the cultures are white, shiny, creamy, and porcelain-like, with fringed margins and with a paler color. Gelatin is liquefied slowly. Liquefaction does not begin before the fourth day. On agar the coccus grows poorly at 18° to 20° C. The cells are small. On Jensen's rice the colonies are white, peculiar, porcelain-like, creamlike, abundant. On potato there is formed a beautiful, white, opaque, porcelain-like growth, visible after forty-eight hours. On carrots, the growth is very poor, showing degenerate cocci. On artichoke, the growth is good and gives after the first day a beautiful, green color. It grows well in ascitic fluid. It gives beautiful, white cultures on solidified blood serum. It grows in milk without coagulating it.

The most recent claim of the discovery of a specific germ for beriberi is made by Okata and Kokubo, two Japanese army surgeons, who have had an excellent opportunity to study the extensive outbreak of beriberi occurring among the

[19] Dangerfield: *Le Beriberi*, Paris (1905).

[20] For a complete description of the bacterium the reader is referred to the original paper.

Japanese soldiers transferred from Manchuria to Japan during the recent Russo-Japanese war. These investigators have isolated a coccus, which generally assumes the shape of a diplococcus but which may also at times present itself as a staphylococcus. They confidently maintain that this organism is the causative factor in beriberi.

The author, working in the Hiroshima Kakke Hospital under the direction of Surgeon-Major Kokubo, has had an opportunity to isolate this identical organism from cases among soldiers suffering from beriberi in Hiroshima. A translation of Okata and Kokubo's first description of the micro-organism, which they claim to be the etiologic factor in *kakke*, has already been published in a previous number of this Journal.[21]

THE THEORY OF ARSENICAL POISONING AS THE CAUSATIVE FACTOR OF BERIBERI.

Among the theories brought forward to explain the etiology of beriberi is that of arsenical poisoning. I shall consider it somewhat in detail. A number of observers who have made beriberi a subject of special inquiry have noticed the frequency of this affection among workers in tin mines. Occasionally, there has been a tendency to regard the disease as a direct manifestation of arsenical poisoning.

Recently, Donald Ross[22] has become an advocate of this theory. He calls attention to the fact that the clinical symptoms of certain cases of beriberi are extraordinarily similar to those shown by the victims of chronic arsenic poisoning which occurred in Chester and Manchester (England) in 1900 and which were characterized by a multiple, peripheral neuritis; in fact, they resembled what appeared to be cases of epidemic, peripheral neuritis. Following out this theory, Ross[23] later reported a case of beriberi which clinically presented features similar to those met with in the dry, paralytic form of the disease; it also resembled the cases of arsenic poisoning observed in England in 1900. Professor Dixon Mann examined a lock of hair from this patient and reported that he found a considerable amount of arsenic. No arsenic had been administered medicinally.

Enlarging upon his researches in this direction, Ross[24] procured twenty samples of hair from beriberi patients, mostly Chinese, from the Penang General Hospital. These were also analyzed by Dixon Mann, who reported that 6 out of the 20 samples contained arsenic; two yielded more than a trace; and two each a decided and a minute trace. The positive samples were nearly all from recent cases of beriberi, the negative ones as a rule from the older ones. Ross draws the following conclusion from the result.

"The probability is very strong that the Penang beriberi is arsenical, especially when we know that the people there largely work in tin manufactories and are brought closely into contact with arsenic."

[21] *Phil. Journ. Science* (1906), 1, 169.

[22] Ross: Beriberi and Chronic Arsenical Poisoning. *London Lancet* (1900), 2, 1677.

[23] Ross and Reynolds: A Case of Beriberi Probably due to Arsenic Poisoning. *Brit. Med. Journ.* (1901), 2, 979.

[24] Ross: Arsenic in the Hair of Beriberi Patients from Penang. *Brit. Med. Journ.* (1902), 1, 329.

Further researches are given in a subsequent report[65] by the same author. Eight samples of the hair of beriberi cases were procured by him from the Singapore Asylum. The analyses made by Mann showed arsenic in the hair from three recent cases and none in the five samples from older cases. Ross further concludes that: "Whatever the truth may ultimately prove to be, the analyses which Prof. Dixon Mann has made seem to suggest that the arsenic, after producing the characteristic neuritis, has gradually disappeared from the hair in some manner, or has, perhaps, been cut away as convalescence has advanced."

Manson (l. c.) in referring to the arsenical poisoning theory of beriberi calls attention to the fact that the mere presence of traces of arsenic in the hair of persons suffering from beriberi could hardly be advanced as a conclusive argument of such an origin of the disease. While he is not prepared to deny the frequent occurrence of arsenical neuritis in the Tropics, he feels quite certain that what is generally considered as beriberi has nothing to do with arsenic and does not represent an arsenical neuritis.

Dunham (l. c.) believes that the results of the analyses reported by Ross, in which only traces of arsenic were discovered, really oppose the arsenic hypothesis and do not support it. He points out that out of many hundred beriberi cases he encountered but one of herpes, such as is frequently found in arsenical intoxication. While arsenic may be and is partaken of by many who are afflicted with beriberi as well as by others, the analyses which have been made are against the supposition that there is a connection between the two (clinically more or less distinct) conditions of arsenical neuritis and beriberi. Upon Dunham's suggestion, arsenic was given to a number of beriberi patients in large doses. No favorable result was observed from this treatment, but several cases recovered in spite of the heroic doses administered.

The question whether arsenic is or is not a normal constituent of the human body is at present open to argument.

A. Gautier[66] claims that in 200 tests he has always found arsenic in the thyroid gland and in the skin and its appendages. His observations are confirmed by other French writers, viz: Lapierre, Pagel Imbert, Badel, and Bertrand. However, Gautier's statements are contested and the presence of arsenic as a normal constituent of the thyroid and the skin is denied by Hoedelmoser,[67] Cerny,[68] and Ziemke.[69] The first mentioned author, in his tests, adopted Gautier's tedious method of digesting and oxydizing 100 grams of the tissues to be tested with 30 to 60 cubic centimeters of nitric acid and 1 cubic centimeter of sulphuric acid, in order to prevent any possibility of losing arsenic by volatilization. In spite of these precautions he could not detect arsenic and consequently refers the results of the French observer to impure reagents.

In order to test the validity of Ross's claim, hair from some of our beriberi patients was analyzed. The samples were taken from the heads of ten native Filipinos, as follows:[70] One from a fatal case of acute, wet

[65] Idem.: Some More Instances of the Presence of Arsenic in the Hair of Early Cases of Beriberi. *Brit. Med. Journ.* (1902), **2**, 837.

[66] Gautier: Sur l'arsenic normal des animaux. *Comp. Rend. hebd. Soc. Biol.* Paris (1902), **54**, 727; also Existence normal et origine de l'arsenic, etc., ibid., 1242.

[67] Hoedelmoser: *Zeitschr. für Physiol. Chemie.*, **33**, 329.

[68] Cerny: *Ibid.*, **34**, 408.

[69] Ziemke: *Deutsche Apotheker Ztg.* (1902), **17**.

[70] The analyses were made in the Chemical Laboratory of this Bureau, the first in 1904 by C. L. Bliss, the last nine by L. A. Salinger, to both of whom I wish to express my thanks.

beriberi, one from a fatal case of acute pernicious beriberi, and eight from cases of subacute or chronic beriberi.

The first sample was shown to be negative by Mr. Bliss, but in order absolutely to check his result, the remaining nine were carefully tested for arsenic, the method used having the following main features: From samples 1 to 9, about 1 gram of each was used for the determination; from the remaining one, 0.5 gram was employed. Organic matter was destroyed in the usual way, the solution then diluted, filtered, and evaporated with sulphuric acid, this operation being repeated several times after the addition of a small amount of nitric acid, until the fumes of sulphuric acid appeared. After all organic matter had been destroyed, the test for arsenic was made in a small Marsh apparatus. No trace of arsenic could be detected in any of the samples; a control by this method was sufficiently delicate to detect 0.01 milligram.

The ten samples of hair from beriberi patients on analysis, therefore, demonstrated the absence of arsenic.

ANIMAL EXPERIMENTS WITH THE OKATA-KOKUBO COCCUS.

During the past six months I have extensively studied the Okata-Kokubo coccus and the relation it bears to beriberi. The results of these experiments and of the investigations undertaken to find this identical organism in beriberi cases occurring in the Philippine Islands may be summarized as follows:

Six strains were selected for cultural and animal experiments. Three were isolated by Professor Okata from beriberi autopsies; one was a culture grown by Professor Kokubo from the urine of a *kakke* patient and two were isolated by myself from the urine of *kakke* patients in Hiroshima, in which place I was working under the direction of Professor Kokubo. One of the last two cultures exclusively showed cocci of the large type. The six strains were grown on the following media: agar, alkaline to litmus; agar, alkaline to phenolphthalein; glucose-agar; litmus-lactose-agar; litmus-milk; bouillon alkaline to litmus; bouillon, alkaline to phenolphthalein; Dunham's peptone solution; gelatine; potatoes. All the cultures were kept in the incubator between 34° to 36° except the gelatine tubes which were maintained at a lower temperature.

A study of the growth of the different strains on the variety of culture media employed, in general confirmed the description given by Okata and Kokubo in their first paper. However, a few minor differences were noticed. These were as follows:

Examination of gelatine cultures during the first two weeks showed no liquefaction.

After twenty-two days on this medium the following conditions were noticed:
Stem Kokubo, heavy growth, superficial liquefaction:
Stem Herzog (large cocci), scanty growth, no liquefaction.
Stem Herzog, very abundant growth, liquefaction.
Stems Okata, I, II, and III, scanty growth, no liquefaction.
Non-inoculated control tube. No liquefaction.

After fifty-six days:
Stem Kokubo. Abundant growth. Very advanced liquefaction.
Herzog (large), scanty growth, no liquefaction.
Herzog I, very advanced liquefaction, like stem Kokubo.
Okata I, II, III, no liquefaction.
Control tube, no liquefaction.

The original communication states that the *kakke* coccus grows in milk without coagulating the casein. Our tests in this respect show:

After twenty-two days' growth in litmus milk:
Stem Kokubo, media fluid, red, little coagulation.
Herzog (large), fluid, red, moderate coagulation.
Herzog I, fluid, red, marked coagulation.
Okata I, II, III, fluid, red, very little coagulation.
After 56 days, all litmus milk tubes were red and the degree of coagulation was as follows:
Kokubo, moderate coagulation.
Herzog (large), marked coagulation.
Herzog I, marked coagulation.
Okata I, II, III, marked coagulation.

Therefore, after a longer period of growth, all stems showed marked acid formation and a varying degree of casein coagulation. The control tube after fifty-six days had shown no changes. On the other media the cultures presented the features already described by Kokubo and Okata. None of them formed any gas in glucose or lactose media.

The following animal experiments were made:

First series.—On November 20, 1905, twelve monkeys (species *Macacus cynomolgus*) were inoculated with the 6 stems, as follows:

Animal number	Date	Amount	Culture.	Stem
Monkey No.—		c. c.		
1473	Nov. 20, 1905	1	5-day-old bouillon culture, second generation of original Japanese culture, intraperitoneally	Kokubo.
1474	do	1	do	Do.
1475	do	1	do	Herzog (large).
1476	do	1	do	Do.
1477	do	1	do	Herzog I.
1478	do	1	do	Do.
1481	Nov. 22, 1905	1	2-day-old bouillon culture, second generation of original Japanese culture, intraperitoneally.	Okata I.
1482	do	1	do	Do.
1483	do	1	do	Okata II.
1511	do	1	6-day-old bouillon culture, second generation of original Japanese culture.	Herzog I.
1512	do		do	Herzog (large)
1513	do		do	Kokubo

These monkeys were kept under observation during fifty-two days. They never developed fever, paralysis, swelling of the lower extremities, difficulty of respiration, nor any of the other symptoms of beriberi. They were, in fact, never otherwise than well, they ate normally during this period, and were discharged from observation on January 12, 1906.

Second series.—On March 15, 1906, twelve monkeys (species *Macacus cynomolgus*) were inoculated with the 6 stems, each animal receiving intraperitoneally 2 cubic centimeters of a 9-day-old bouillon culture. The animals were of both sexes, and included young and full-grown individuals.

Animal number.	Amount	Stem.
Monkey No.—	*c. c.*	
1836	2	Kokubo.
1837	2	Do.
1838	2	Okata I
1839	2	Do
1840	2	Okata II
1841	2	Do.
1842	2	Okata III
1843	2	Do
1844	2	Herzog I
1845	2	Do
1846	2	Herzog (large)
1847	2	Do.

These animals were kept under observation for over one month. They remained perfectly well during this time.

Third series.—Twelve half-grown guinea pigs were inoculated on February 26, 1906, as follows: Three standard *oesen* of a 6-day-agar culture were suspended in 10 cubic centimeters of physiological salt solution. Each guinea pig received 1 cubic centimeter of this suspension intraperitoneally or subcutaneously, as shown by the following table:

Animal number	Amount	Stem	Inoculation.
Guinea pig No.—	*Standard oese*		
1806	0.3	Okata I	Intraperitoneally.
1807	.3	do	Subcutaneously.
1808	.3	Okata II.	Intraperitoneally.
1809	3	do	Subcutaneously.
1810	.3	Okata III.	Intraperitoneally.
1811	.3	do	Subcutaneously.
1812	.3	Kokubo	Intraperitoneally.
1813	3	do	Subcutaneously.
1814	.3	Herzog I	Intraperitoneally.
1815	.3	do	Subcutaneously.
1816	.3	Herzog (large)	Intraperitoneally.
1817	.3	do	Subcutaneously.

The animals were kept under observation for nearly two months. They remained well and did not develop any disease.

Fourth series.—On March 15, 1906, twelve young guinea pigs were inoculated intraperitoneally, each with 1 cubic centimeter of a 9-day-old bouillon culture of the different stems, as follows:

Animal number.	Amount.	Stem.
Guinea pig No.—	c. c.	
1893	1	Kokubo.
1894	1	Do.
1895	1	Okata I.
1896	1	Do.
1897	1	Okata II.
1898	1	Do.
1899	1	Okata III.
1900	1	Do.
1901	1	Herzog I.
1902	1	Do.
1903	1	Herzog (large).
1904	1	Do.

These animals were kept under observation for over one month. They remained well.

Fifth series.—On March 15, 1906, twenty-four young rabbits were inoculated, each receiving intraperitoneally 1 cubic centimeter of a 9-day-old bouillon culture of one of the 6 stems.

Animal number.	Amount.	Stem.
Rabbits Nos.—	c. c.	
1869-1872	1	Kokubo.
1873-1876	1	Okata I.
1877-1880	1	Okata II.
1881-1884	1	Okata III.
1885-1888	1	Herzog I.
1889-1892	1	Herzog (large).

The twenty-four animals were kept under observation for over one month. They remained perfectly well.

Sixth series.—On March 16, 1906, twenty-one rats (mostly of the species *Mus decumanus* but also a number of *M. rattus*) were inoculated intraperitoneally, each receiving a 9-day-old bouillon culture, as follows:

Rats Nos. 1848 to 1859 each 1 cubic centimeter of stem Kokubo, and rats Nos. 1860 to 1868 each the same amount of Okata No. II.

March 22, a. m. Rat No. 1848 died during the previous night. Body not yet putrid, very much emaciated. On section a grayish white floccule, the size of a millet seed, was found on the surface of a loop of the small intestine;

otherwise no pathological changes were observed. The floccule was composed of leucocytes and endothelial cells, and contained innumerable, small diplobacilli. Cultures were made from this floccule and from the spleen and heart's blood. The tubes inoculated from the floccule developed a small bacillus, but no cocci. The small intestine of this animal had evidently been wounded during the intraperitoneal inoculation. The cultures from the spleen and heart's blood were negative.

March 27, 1906. Rat No. 1849 was found dead in the morning. Body much emaciated, already decidedly putrid. On post-mortem examination there was found a caseous abscess the size of a very small hazelnut in the anterior body wall opposite the lower ribs of the left side. This abscess contained many slender, non-acid proof bacilli. Tubercle bacilli were not found.

The following rats died subsequently: No. 1860, March 27; No. 1861, March 27; No. 1863, March 28; No. 1856, April 7; No. 1859, April 10. Smears from the different organs and inoculations of culture media were made from each animal. In no case was it possible to regain from the tissues the cocci which were inoculated on March 15, and there appears to be no doubt that the inoculated organism had nothing to do with the death of the experimental animals. It may be stated that a number of the laboratory rats not inoculated but living under the same conditions, died at about this time. The other animals of this series inoculated with the *kakke* coccus remained alive; none of them developed any symptoms of beriberi.

BLOOD EXAMINATIONS OF BERIBERI CASES IN MANILA.

Blood examinations in twelve cases of beriberi were made by the author during the years 1904 and 1905 with the object of obtaining the specific micro-organism of the disease from the blood, if it was present therein. These examinations gave a negative result and no detailed record of them has been preserved. Since my return from Japan, over forty additional blood examinations have been made, and detailed records of these have been kept. On December 7 and 9, 1905, 39 male inmates of Hospital B of Bilibid Prison, who were suffering at this time with all types of beriberi except that of the most acute, pernicious variety, were examined. Some of the cases were of the wet, hypertrophic type, others of the dry and atrophic variety; in certain ones all of the more prominent symptoms of beriberi were still present; in others, convalescence was well advanced. These blood examinations were undertaken with the assistance of Mr. Charles B. Hare, at that time a member of the staff of the Biological Laboratory.

The method of procedure was as follows:

The skin over the median cephalic vein of the elbow was cleansed with soap and water, bichloride solution, and alcohol. The vein was then pierced with a hypodermic syringe needle and from 1 to 2 cubic centimeters of blood withdrawn and at once injected into a 100-cubic-centimeter flask containing 50 cubic centimeters of slightly alkaline bouillon. The cultures were then incubated at 37° and kept under observation for several weeks.

Thirty-three of the flasks remained permanently sterile. In six, a growth developed in which the following organisms were isolated.[31]

Culture No. 2 developed a coccus, No. 4 a staphylococcus, No. 13 a large staphylococcus, No. 19 a spore-bearing bacillus, No. 26 a large diplococcus, and No. 37 a medium-sized, slender, spore-forming bacillus. All of the above stained well by Gram's method.

The four varieties of cocci which were obtained have not as yet been very extensively examined as to their cultural properties. However, none of them seem to be identical with the cocci brought from Japan, and experiments made with them with the object of producing beriberi in animals have all been negative, as will be seen from the following table:

Seventh series.—Twelve monkeys, each received intraperitoneally one-fifth of an oese of an agar culture in 1 cubic centimeter of physiological salt solution, as follows:

Monkey No.—	Organism isolated from Bilibid beriberi case No.—	Monkey No.—	Organism isolated from Bilibid beriberi case No.—
1655	2	1661	13
1656	2	1662	13
1657	4	1663	26
1658	4	1664	26
1659	19	1665	37
1660	19	1666	37

These monkeys were well during the days following the injections and they neither developed symptoms of beriberi nor manifested appearances of any disease.

In a case of hypertrophic beriberi,[32] which quickly terminated fatally, a blood examination was made January 26, 1906, five days before death. (See necropsy No. 1636, page 747 of this article.) At this time the patient presented all of the symptoms of an acute and profound case of beriberi. The examination included anaërobic cultures.

About 5 cubic centimeters of blood were withdrawn from the median cephalic vein. Two flasks containing 50 cubic centimeters of bouillon were inoculated, each with 1 cubic centimeter of blood. One was kept aërobically, and the other in a hydrogen atmosphere, anaërobically. Several agar tubes were likewise inoculated from the blood, some of which were also developed aërobically, and some anaërobically (Buchner's pyrogallic acid method being used). The cultures were left under observation during from four to five weeks. They remained permanently sterile.

Apparently, all of the cultures from this case had remained sterile, but the possibility was considered that perhaps something ultramicroscopic in character and which did not give rise to any changes in the culture media, detectable by either ordinary macroscopic or microscopic examina-

[31] The cultures are designated by the same numbers under which the 39 cases of beriberi were recorded.

[32] Occurring in the Civil Hospital.

tions, might have developed. Hence, 6 monkeys were inoculated from the culture media, which had been kept both aërobically and anaërobically.

Eighth series.—

Animal number.	Date.	Amount.	Culture.
Monkey No.—		c. c.	
1717	Feb. 2, 1906	1	Aërobic culture A.
1718	do	1	Anaërobic culture A.
1719	do	1	Aërobic culture B.
1720	do	1	Anaërobic culture B.
1721	do	1	Aërobic culture D.
1722	do	1	Anaërobic culture D.

These animals never showed any sign of disease and remained permanently well.

Before the bouillon cultures from the above case of beriberi were used for inoculating the animals recorded in the preceding tables, subcultures from the tubes were made on agar. These were preserved in the incubator both under aërobic and anaërobic conditions. After four weeks it was noticed that each of two of the tubes had developed a single colony. The one which had been kept under anaerobic conditions contained large, yellow cocci, which later also grew aërobically; the aërobic tube showed a dirty, grayish-brown, very tenacious colony composed of bacilli, which stained very irregularly, and appeared morphologically somewhat like diphtheria bacilli from an older culture. After transplanting a portion of this growth to a fresh agar tube the remainder of the colony was rubbed up with 15 cubic centimeters of sterile salt solution; with this very imperfect suspension, which contained comparatively large flocculi, six monkeys were inoculated, each with about 1.3 cubic centimeters of fluid.

Ninth series.—

Animal number	Date.	Suspension.
Monkey No.—		c. c.
1825	Mar 7, 1906	1.30
1826	do	1.30
1827	do	1.30
1828	do	1.30
1829	do	1.30
1830	do	1.30

The animals remained permanently well.

Cultures were made from the internal organs in a number of post-mortem examinations of beriberi cases and examined with the view of ascertaining whether the identical coccus brought from Japan was present. Most of these were negative. An acute case of beriberi died at Bilibid

Hospital after an illness of only a few hours and the necropsy (No. 1634) was performed two hours after death. Cultures taken from the very much enlarged spleen developed colonies of a pale-yellowish diplococcus which, in most media, showed considerable similarity to the cocci brought from Japan. From these cultures five rabbits were inoculated.

Tenth series.—Three of the animals (1747, 1748, 1749) received intraperitoneally 1 cubic centimeter of a 2-day-old bouillon culture, and two (1750 and 1751) received subcutaneously 1 cubic centimeter of the same culture. These animals, which were under observation for two months, never showed any signs of disease and remained permanently well.

In order to prepare an anti-serum for the purpose of making agglutination tests, other rabbits were inoculated with the Kokubo coccus in successively increasing doses. All of these animals remained well. One of the rabbits, when finally bled, after having been injected at intervals on numerous occasions during a period of seventy-eight days, furnished a serum of only very low agglutinating power.

On March 7, 1906, a post-mortem examination (No. 1674) was made upon the body of a young Japanese who had been ill but a few days. The clinical diagnosis of acute, pernicious beriberi was confirmed at autopsy. During this examination two agar tubes were inoculated from the cerebro-spinal fluid obtained by puncture at the third lumbar vertebra with a sterile syringe, and another was inoculated from the heart's blood. Pieces of the wall of the stomach and of the duodenum, together with some of the gastric contents, were placed in a flask containing several hundred cubic centimeters of alkaline bouillon the latter was then heated to 80° C. and kept at that temperature for about ten minutes. It was then cooled in the refrigerator and subsequently incubated. It developed a spore forming bacillus. The tube inoculated from the heart's blood remained permanently sterile, and the tubes inoculated from the cerebro-spinal fluid developed colonies of different bacilli, evidently contaminations.

Monkeys and rabbits were inoculated on March 26, 1906, with the cultures obtained from the above necropsy (No. 1674), after the latter had grown in the incubator for nineteen days. Of the bouillon culture 1.5 cubic centimeter was injected intraperitoneally, of the agar cultures six normal oesen were rubbed up with 20 cubic centimeters of salt solution, and each animal received intraperitoneally 1.5 cubic centimeters of this suspension, as follows:

Eleventh series.—(March 26.)

Animal number.	Quantity.	Culture
	c. c.	
Monkey No. 1916	1.5	From stomach.
Monkey No 1917	5	Do.
Rabbit No. 1918	5	Do
Rabbit No. 1919		Do.
Monkey No. 1920	5	Cerebro-spinal 1.
Monkey No. 1921	5	Do.
Rabbit No. 1922	.5	Do.
Rabbit No. 1923	.5	Do.
Monkey No. 1924	.5	Cerebro-spinal 2.
Monkey No 1925		Do.
Rabbit No. 1926		Do.
Rabbit No. 1927	.5	Do.

One rabbit (No. 1919) and one monkey (No. 1917), which had received 1.5 cubic centimeters of the bouillon culture obtained from the stomach, died.

Monkey No. 1917 was found dead March 29. The post-mortem examination revealed nothing characteristic; smears from the organs showed a very small diplococcus, absolutely unlike the Okata-Kokubo coccus both in morphology and in cultural properties.

Rabbit No. 1919 was found dead on March 30. The autopsy showed a peritonitis with blood-tinged fluid in the abdominal cavity; the liver contained numerous microbic foci. The cultures inoculated from the organs developed a large, spore-forming bacillus, staining by Gram's method.

SPECIAL PATHOLOGY.

Baelz, Scheube, N. Miura, Yamagiwa, and Pekelharing and Winkler have particularly advanced our knowledge of the special pathology of beriberi.

Pekelharing and Winkler,[a] after giving due credit to Baelz and Scheube for having first shown that the principal seat of the disease in beriberi is the peripheral nervous system, point out that the changes in the nerves are not of the nature of an inflammatory, but of a degenerative, process. Their conclusions read as follows:

"Anatomical examination is in perfect accord with the inference drawn from clinical observation, that beriberi is a multiple neuritis. An extreme and very extensive affection of the peripheral nerves predominates, and as one approaches the central nervous system, the pathological evidence of nerve change diminishes. The anterior roots of the spinal nerves are always healthy; but in the posterior roots one sometimes meets with a slight atrophy of the fibers, which is always infinitely less on the proximal side of the intervertebral ganglion than on the distal prolongation of the nerve. In the spinal cord some variations of secondary importance are met with in the large nerve cells of the anterior cornua, but more constant still is a slight loss of fibers in the extension of the posterior roots in the two radicular zones, unaccompanied by any swelling of the axis cylinder, granular degeneration of cells, or multiplication of nuclei. We consider that we have established the claim that beriberi should be ranked among the diseases that are described under the name of multiple peripheral neuritis. However highly we esteem the work done by Baelz and Scheube, we consider that the proof has only now been given by us, inasmuch as we have clearly demonstrated that the nerves are attacked in the very first phase of the disease, and our anatomical observation has undoubtedly confirmed this affection of the nerves in a very great number of cases. In every beriberi patient some symptoms of degeneration, as well as of regeneration, in the peripheral nerves can often be found."

Pekelharing and Winkler also demonstrated that beriberi is not a form of pernicious anæmia, as had previously been claimed. They made a number of systematic blood examinations and proved that neither an oligocythemia nor an oligochromæmia of a marked degree was present. A number of other authors (among them Wright) have later confirmed the results of their investigations in this respect. Wright estimated the hæmoglobin and made blood counts in 26 cases of beriberi. A moderate anæmia was found in several cases. The number of red-blood corpuscles varied from 4,000,000 to 6,120,000, and the leucocytes from 6,720 to 7,600.

[a] Pekelharing and Winkler: *Beriberi*, English edition (1893), London.

Yamagiwa,[34] after a study of a large autopsy material, enumerates the most important pathologic changes in beriberi as follows: (1) Dilatation and hypertrophy of the right ventricle, and dilatation of the left; fatty metamorphosis of the myocardium; (2) degeneration of the peripheral nerves; (3) atrophy and degeneration of the skeletal muscles; (4) parenchymatous degeneration of the kidney; (5) hydrops. In other words, all the pathological changes in *kakke* are regressive in nature, with the single exception of the hypertrophy of the myocardium.

Yamagiwa, assisted by Yamanouchi,[35] recently has investigated the claim of Glogner – i. e., "that beriberi is primarily a disease of the heart and skeletal muscles (fragmentation) with a loss of continuity of the elastic tissue of the vessels, particularly of the pulmonary artery and its branches." The Japanese authors from their histologic studies conclude that Glogner's statements are not at all tenable and that the elastic fibers of the pulmonary artery and its branches are practically intact in beriberi.

In seven beriberi necropsies Plehn (l. c.) found the liver in six presenting the changes of interstitial hepatitis and in one, those of chronic congestion with secondary induration. This observer is therefore inclined to look upon the interstitial hepatitis as an important morbid change in beriberi.

Hermann Duerck,[36] who also has recently studied beriberi in Sumatra, states that the surrounding connective tissue, the fine connective tissue—i. e., the endoneurium – the myelin sheath, and even the axis cylinders of the nerves are all affected and that alterations are to be found even in acute cases. In the instance of a Chinese coolie, sick only fourteen days, who complained mainly of dyspnœa and palpitation of the heart, disturbances of locomotion increasing almost to complete paralysis were present. In this case sections of the vagus nerve showed almost complete degeneration of the myelin sheath, with irregularly fringed fragments, or with fragments resembling portions of a rosary. In other places the axis cylinders were entirely devoid of their myelin sheaths, many of which were found collapsed and with the neurolemma nuclei increased. The axis cylinders were spirally twisted, irregularly undulating, and in some places even broken up into fragments. The heart in the same case was dilated and resembled a flabby, thin-walled sac. Microscopically, the myocardium showed most extensive changes. The muscle cells were attenuated, having been pushed apart by a homogeneous, glassy mass, in which small, undulating clefts containing cell nuclei surrounded by some granular protoplasm were occasionally seen. A high magnification revealed the fact that this homogeneous substance was a degeneration product of the fibrils of the heart muscle cells. In many places there could very distinctly be seen a direct transition of the striped substance into the hyaline mass. The muscle cells were also separated longitudinally into a number of fine, parallel bands. This process resulted in the picture of free nuclei surrounded by a small amount of granular sarcoplasm. The bands evidently had undergone hyaline degeneration and the hyaline material included the nuclei, with a small amount of sarcoplasm. According to the report, the degeneration of the nerves could be followed step by step by the melting of the hyaline sheath, vacuolation, and the formation of honeycombed or foamy masses. Large cells, evidently leucocytes loaded with some of the degenerated hyaline, were found in the immediate neighborhood of the capillaries which supply the endoneural connective

[34] Yamagiwa: Beitrage zur Kenntniss der Kakke. *Virchow's Arch.* (1899), **156**, 451.

[35] Yamagiwa and Yamanouchi: Ueber das Wesen der Kakke. *Salkowski Festschrift.*

[36] Duerck: Ueber Beriberi, etc. *Münch. Mediz. Wochenschr.* (1905), **52**, 1913.

tissue. The neurolemma nuclei were enlarged and proliferated, and the proliferating endoneurium had given rise to fibrous tissue. The voluntary muscles of the body also showed profound changes. Individual fibers could be seen, twisted spirally and drawn together between other muscle fibers, which were still well preserved. The sarcolemma nuclei were much increased. The sarcolemma sheath was partly retracted from the contents; it also in many places showed irregular protrusions. The contractile protoplasm had been expelled in the shape of circumscribed, roundish masses which no longer showed any striation.

SUMMARY OF THE PATHOLOGY.

The following is a general outline of the special pathology of beriberi, summarized from a study of the literature on the subject and from that of a number of fatal cases examined by the author in Manila during the past three years:

The bodies of patients dead of beriberi generally promptly develop marked post-mortem rigor. However, in cases which succumb slowly to the atrophic type or in which complicating, wasting diseases, such as tuberculosis, amœbic dysentery, malaria, etc., are present, the post-mortem rigidity may be quite insignificant; this, however, is the exception and not the rule. When death has occurred very rapidly, as in the acute pernicious variety, the author has observed the post-mortem rigor develop very early and to become as strong as that met with in fulminating cases of Asiatic cholera or bubonic plague. According to M. Miura, post-mortem rigidity generally shows itself in beriberi within two hours after death, reaching its maximum within five or six hours post-mortem and lasting for a considerable period of time. The skin of the corpse is pale, with cyanotic patches scattered here and there. Occasionally cutaneous hemorrhages may be observed. On section the superficial veins discharge a large amount of dark, fluid blood and in the majority of cases, excepting only those of the atrophic variety or of long standing, the subcutaneous tissue is œdematous and exudes a considerable amount of serous fluid. The subcutaneous œdema is usually best marked at the anterior thoracic region and over the anterior surfaces of the lower extremities. Hydropericardium, ascites, and hydrothorax are very frequently encountered in beriberi autopsies. Hydropericardium is the most common of these serous effusions. The average of the post-mortem figures given by Scheube, Lodewjik-Weiss, Pekelharing and Winkler, and Yamagiwa, in a total of 256 cases, shows 66 per cent of hydropericardium. The author has likewise found hydropericardium in the majority of his autopsies on cases of this disease. Subepicardial and subpleural petechiæ are also not infrequently encountered.

The heart, of all the internal organs in beriberi, most constantly shows very characteristic changes. The myocardium, as a whole, is hypertrophic, and the hypertrophy is usually most marked in the right ventricle; but the left one may likewise be enlarged. The organ is then increased in size in all of its diameters and in its weight. The average of

the latter in 93 cases of beriberi reported by Yamagiwa was 368 grams, whereas the normal Japanese heart weighs from 250 to 300 grams. The right ventricle was hypertrophic in 73 of these 93 cases, the average diameter being 6.1 mm., compared with a normal diameter of 2 to 3 mm. The right ventricle, in particular, is generally not only hypertrophic but also markedly dilated, so that there is present a relative insufficiency of the tricuspid valve. All of the chambers generally contain a large amount of dark, fluid blood. Chicken-fat clots are also generally found in the heart in atrophic cases in which the death struggle has been protracted. The coronary veins are much dilated. The myocardium may be normal, but often it is found to be more or less cloudy and mottled, in consequence of diffuse, fatty degeneration.

As a rule, the lungs are œdematous, congested, and contain little air; however, occasionally they are emphysematous, and we have also seen some cases in which they were exceptionally collapsed and dry. At times, some catarrhal bronchitis may be observed and in some cases, where the pneumogastric has been profoundly affected, aspiration pneumonia has been seen. In beriberi the spleen shows no changes characteristic for this disease. It is true that in the Tropics a considerable enlargement has frequently been observed in beriberi; but this must be looked upon as a mere coincidence, because one must not forget that in tropical postmortem material, no matter what the immediate cause of death has been, enlargement of the spleen is very frequently found. However, in beriberi this organ often shows cyanotic induration of a moderate degree. The kidneys, in acute cases, are markedly congested, and some cloudy swelling and fatty degeneration are frequently observable. The liver is generally swollen and congested. Where chronic passive congestion has lasted for some time, on section we find the characteristic appearance of a nutmeg liver.

In many cases of beriberi, particularly those of the subacute variety which have not lasted too long, we find great hyperæmia of the gastric and duodenal mucosa. Occasionally, ecchymoses are even found in the mucous membrane of this organ. Ellis[37] reports that he found the lining membrane of the stomach congested in 31 out of 57 fatal cases of beriberi, and in most of these it was intensely congested, especially on the ridges of the corrugations. In four instances there were blood clots present in the stomach, possibly due to the persistent vomiting from which the patient had suffered prior to death. This condition of the gastric and duodenal mucosa has so impressed several observers that they hold the stomach and duodenum to be the portal of entrance of the specific virus of beriberi. We have, like others, observed this hyperæmia in most of our necropsy cases; but we are inclined to

[37] Ellis: Contribution to the Pathology of Beriberi. *London Lancet* (1898). 2, 985.

look upon it as a purely mechanical, passive process due to general venous congestion, which often finds so marked an expression in the condition of the liver. The small intestine, excepting the duodenum, and the large intestine show no particular changes in beriberi.

The peripheral nerves, particularly those of the lower extremities, are almost without exception profoundly affected in this disease, but the changes are rarely noticeable to the naked eye. The changes found on microscopical examination clearly indicate that the most characteristic anatomical morbid process in beriberi is the degeneration of the peripheral nerves. This observation was first made by Baelz, Scheube, Miura, and Yamagiwa, and has later been confirmed by a considerable number of observers, including Pekelharing and Winkler, Wright and Duerck.

Summary of the histopathological changes.—In summarizing the histopathological changes the following lesions should be emphasized: The myocardium usually shows a more or less incomplete loss of the striation of its fibers. The latter are finely vacuolated, although larger vacuoles are also occasionally seen. Fragmentation and segmentation are generally present but it is not justifiable to attach as great a significance to these lesions in beriberi as Glogner has recently done, because they are so frequently found in a variety of diseases that they are not of specific importance. Among the changes in the myocardium must also be mentioned an occasional increase in the interstitial connective tissue. The lungs show no characteristic histological changes, but, in cases where there has been much congestion and œdema, dilated and densely filled interalveolar capillaries are present and the alveoli themselves contain a granular or coagulated, homogeneous material. Occasionally there is an increase of the interalveolar, the perivascular, and the peribronchial connective tissue. The spleen shows no characteristic changes, but an increase in the connective tissue, more or less endothelial proliferation and crowding of the pulp spaces with blood elements are frequently encountered. In the kidneys, as emphasized by Yamagiwa, are usually found cloudy swelling and fatty degeneration of the tubular epithelia. In uncomplicated cases, these parenchymatous changes are usually of a moderate degree. In the liver there is a great congestion of the intralobular capillaries, with fatty degeneration and cloudy swelling and even complete necrosis of the parenchyma cells. A change in the liver, to which Plehn has recently attached considerable importance, we have met with almost without exception. It consists of interlobular, inflammatory foci, composed of small, round cells which infiltrate the interlobular fibrous connective tissue. In fact, Plehn speaks of an interstitial hepatitis in beriberi. The mucosa of the stomach and duodenum exhibits dilated and congested vessels and in a number of cases a profound eosinophilia has been present. In the cases in which the eosinophiles were increased the presence of uncinaria could be excluded, and it is possible that this eosinophilia may have a certain significance in beriberi.

The most characteristic histological changes in beriberi are found in the peripheral nerves. Here, a degeneration of the myelin sheath occurs which varies from insignificant alterations to the most profound lesions. The myelin sheath is broken up into balls and beads, becomes gradually honeycombed and finally entirely disappears. Where it is profoundly altered, the axis cylinders likewise show distortion, irregular outlines, coiling up, or complete disappearance. These changes have been so completely described on a number of occasions and particularly by Yamagiwa and recently by Duerck, that it is not considered necessary here to give any further description of them. A proliferation of the neurolemma nuclei is generally associated with the degenerative changes in the myelin sheath and the axis cylinder. However, I have never found any changes of an inflammatory nature and agree with those who think that the morbid processes in the peripheral nerves in beriberi are purely degenerative in character. I have seen the profound degenerations in the peripheral nerves from very acute cases which Duerck has described. This seems to point to the fact that the poison of beriberi, whatever it may be, accumulates in the body and then leads to a sudden explosion. It is clear that such fundamental alterations in the nerves as are seen in acute, pernicious cases, can not have been produced during the few hours or days in which the disease apparently has continued, it is more probable that they are due to an agent which has accumulated during a certain period of time without leading to any manifest symptoms. In the more chronic cases, degenerative changes are also seen in the muscles supplied by the peripheral nerves and in these instances the voluntary muscle fibers are found with indistinct outlines and striation, and the sarcoplasm is either homogeneously swollen or shrunken away from the sarcolemma.

Rumpfe and Luce and Wright have also described degenerative changes in the axis cylinders and nerves of the cord and the latter mentions alterations in the ganglion cells of the spinal ganglia.

POST-MORTEM RECORDS AND HISTOLOGICAL STUDIES OF A NUMBER OF CASES OF BERIBERI.

The following post-mortem and histological studies of a number of cases are included for the purpose of illustrating the pathological types of the disease:

Case No. 1.—Acute pernicious beriberi with advanced degeneration of peripheral nerves.—Necropsy No. 1547, November 24, 1905: Lope Jacob, a Filipino prisoner in Bilibid penitentiary, had been working in the prison during November, 1905. As far as was known he had not been recently ill. During the night of November 23 he was attacked with palpitation of the heart, shortness of breath, weakness, and anxiety. At 1 a. m. his condition became so alarming that he was taken to the prison hospital. Here he rapidly failed and died at 5.25 a. m.

AUTOPSY five hours after death: Body of native about 20 to 25 years old. Rather strong, heavy set; normal development; cutaneous surface slightly œdematous; slight pitting on pressure over tibial region; rigor mortis moderate in upper extremities; very marked in lower ones and jaws. On section, the fat and the subcutaneous tissue are found to be moderately oedematous. Muscles very moist and of a pale-pink color. Superficial veins discharge much dark, fluid blood. The peritoneal cavity contains 650 cubic centimeters of a clear, amber-colored fluid. The diaphragm reaches to the lower border of fourth rib. Pericardial fluid considerably increased. *Heart* contains a large amount of dark fluid blood, also chicken-fat clots. On the anterior surface of the right ventricle are seen a number of small, confluent, subepicardial petechiæ; right auriculo-ventricular opening easily admits four fingers; right side much dilated; myocardium of right side moderately hypertrophied; pockets of pulmonary valves deep; left ventricle slightly hypertrophied; myocardium of fair consistency, of a general pink color with here and there a slight yellow mottling; valves in general normal. Endocardium smooth; at the beginning of the aorta a few atheromatous spots; coronary arteries normal; weight, 305 grams. *Lungs* collapsed; poor in air; grayish-pink in color with some purplish-blue spots on posterior surface of lower lobes. Pleuræ smooth; no adhesions. Lungs on section, dry; poor in blood; bronchial glands not enlarged; bronchial mucosa normal. Larynx normal; tonsils hypertrophied and congested; crypts deep and ragged. *Spleen*, tense, capsule transparent except over a small, circumscribed, opaque and thickened patch in the middle of the posterior border. On section, of a dark, chocolate-brown color and congested; pulp of good consistency; trabeculæ and follicles both distinct; follicles enlarged; weight, 365 grams. *Kidneys:* perirenal fat œdematous; both kidneys normal in size; capsules smooth; color, pinkish-gray; consistency increased; on section, congestion of a moderate degree is seen, the surface is dull, slightly yellowish, pelves smooth, relation of cortex to medulla, normal. Ureters, normal. Suprarenals, normal in size, deeply pigmented. *Bladder* contracted, mucous membrane pale. Prostate small and normal. *Stomach and duodenum* normal in outline and size, mucosa quite markedly hyperæmic; pancreas normal. *Liver* swollen, capsule transparent, purplish-blue with yellowish mottling, lobules indistinct, congested; gall bladder and bile ducts normal. *Intestines:* serosa pale and shining; wall of entire tract is œdematous. Mucosa of small intestine, except that of duodenum, pale; that of large intestine, swollen and hyperæmic, the hyperæmia not being uniform but generally present as small, irregular patches at the apices of the folds, and particularly well marked at the ileo-cæcal valve. *Brain:* weight 1,375 grams; dura adherent, thickened and opaque. Pacchionian granulations large; fluid in ventricles normal; brain tissue slightly hyperæmic, otherwise normal. Peripheral nerves, pneumogastric, obturator (crural branch), and popliteal have a normal appearance.

ANATOMICAL DIAGNOSIS.—*Hydropericardium, dilatation and moderate hypertrophy of the right, moderate hypertrophy of the left ventricle, moderate fatty degeneration of the myocardium, subepicardial petechiæ, enlargement and congestion of the spleen, congestion, fatty and parenchymatous degenerations of the kidneys and liver, marked hyperæmia of the gastric and duodenal mucosa, chronic catarrhal inflammation of the mucosa of the large intestine; ascites. General œdema of the subcutaneous connective tissue. Acute pernicious beriberi.*

MICROSCOPICAL EXAMINATION.—The fibers of the *myocardium* show a somewhat indistinct striation, the longitudinal striæ in particular are hazy and not sharp. The interstices between the fibers are rather wide; fragmentation and vacuolation are occasionally seen. *Kidneys:* the vessels of both cortex and medulla are moderately congested; glomeruli normal, but the lining epithelia of the convoluted tubules of the cortex generally show a marked degree of cloudy swelling.

Suprarenals: vessels highly congested, cells of the *zona fascicularis* highly vacuolated. *Liver:* the parenchyma cells show a moderate degree of fatty infiltration and degeneration. The interlobular connective tissue exhibits acute, inflammatory foci, composed of small, round cells. *Spleen* normal, pulp spaces densely filled with blood. Here and there one sees a pigmented malarial parasite; eosinophilic cells are very numerous throughout the sections. In the *stomach*, the *duodenum* and also in the *large intestine* the vessels of the mucosa are highly congested and the eosinophiles increased, but otherwise the organs are normal. The eosinophilic cells are found in largest numbers in the lower strata of the mucosa, next to the muscularis mucosa. Here are often seen from 30 to 60 eosinophilic leucocytes in one field, one-twelfth oil immersion, ocular No. 3; length of tube, 170 millimeters. The pancreas is normal. The tonsils are normal but in the recesses of the crypts there are found a large number of bacilli greatly resembling those of diphtheria. Sections from both the *crural* and the *popliteal nerves* show profound degenerative changes. The latter nerve is more markedly affected. Few intact myelin sheaths are visible. The remaining ones are nodular, beaded, fragmented, and in a state of complete, foamy or honeycombed degeneration. The axis cylinders are frequently irregular, shriveled, more or less twisted, or entirely absent. The neurolemma nuclei are moderately increased. Inflammatory changes are not present.

Case No. 2.—Acute pernicious beriberi. Necropsy No. 1505, January 3, 1906: Jorge Madulid, 33 years old, a Filipino prisoner in Bilibid, suffered slight malaise for several days before his admission to the hospital at about 4 o'clock on the afternoon of January 2, 1906. At this time he was very ill, suffering with restlessness, shortness of breath, palpitation of the heart, and rapid and weak pulse. His symptoms increased in severity and he died at 9.45 p. m.

AUTOPSY January 3, 1906, fourteen hours after death: Body of a strong, well-nourished male Filipino about 30 to 40 years old. The skin at the dorsum of the feet and at the anterior surfaces over the tibiæ is slightly œdematous. Rigor mortis moderate. On section the superficial veins discharge a considerable amount of dark, fluid blood. The subcutaneous tissues are moderately œdematous, the muscles pale-pink and moderately moist. The abdominal cavity contains about 50 to 100 cubic centimeters of a clear, straw-colored fluid. The pericardium is considerably distended and contains 100 to 150 cubic centimeters of a liquid of the same color. The *heart* is enlarged, particularly the right ventricle. Here the myocardium measures from one half to three-fourths of a centimeter in thickness. Both sides of the heart contain much dark, fluid blood besides chicken-fat clots. The auriculo-ventricular opening of the right side is considerably enlarged and easily admits four fingers. Both the pericardium and endocardium are smooth and the former shows a few, very small petechiæ. The myocardium as a whole is rather soft and flabby and of a pale-pink and grayish-yellow color. The heart weighs 340 grams. The *lungs* are heavy, the pleuræ smooth and transparent, showing quite a number of petechiæ and ecchymoses. On section, the lungs are dark, reddish brown in color, highly congested, and very poor in air. The mucosa of the larynx, trachea and bronchi is somewhat swollen, hyperæmic and covered with a thin, foamy, slightly blood-tinged mucus. The *spleen* is considerably enlarged. The capsule is of a dull gray color, quite opaque, and here and there shows circumscribed areas of peri-splenetic thickening. The resistance of the organ is increased. On section, it is found to be dark, reddish-brown in color and very much congested. The trabeculæ are very distinct and quite noticeably widened. The pulp is highly congested. The *kidneys* are normal in size, grayish-pink in color on the surfaces and dull and somewhat grayish-yellow on the cut surface. Ureters, bladder, etc., are normal. The *liver* is somewhat swollen, its margins rounded, capsule smooth, transparent and dark, purplish-brown

in color. On section the organ discharges a large amount of dark, fluid blood and the surface presents to a moderate extent the picture of a nutmeg liver. The gall bladder contains a considerable quantity of dark, greenish-yellow bile, its walls are somewhat œdematous. The mucous membrane of the *stomach* and *duodenum* is moderately hyperæmic but does not show either petechiæ or ecchymoses. In general, the *intestines* are normal. Pancreas is normal. The *brain* is quite œdematous, somewhat hyperæmic, but otherwise normal. The peripheral nerves and skeletal muscles show no macroscopic changes.

ANATOMICAL DIAGNOSIS.—*Hypertrophy of the right ventricle, congestion and œdema of the lungs, enlargement, fibrosis and congestion of the spleen, marked parenchymatous degeneration of the kidneys, congestion of the liver, hydropericardium, ascites, slight general œdema of the subcutaneous tissues, œdema of the brain. Acute pernicious beriberi.*

MICROSCOPICAL EXAMINATION. The myocardial fibers show a moderately clear striation; here and there may be distinctly seen the fine dust-like vacuolation of fatty degeneration and the coarse vacuoles of fatty infiltration. Occasionally, fragmented fibers are met with. The nuclei are generally sharp in outline and well stained. The interstitial connective tissue is slightly increased. In the pulmonary sections the vessels are all congested, particularly the inter-alveolar capillaries. There is some increase of connective tissue around the veins and arteries but the inter-alveolar connective tissue is not increased. Many of the alveoli contain granular material, desquamated epithelia, few leucocytes and a considerable number of erythrocytes; some alveoli are completely filled with blood In the *spleen* the trabeculæ are widened and the connective tissue of the pulp is increased. A considerable proliferation of endothelial cells of the pulp spaces is discernible The follicles are ill-defined. Malarial pigment or plasmodia are not found. In the *renal sections* considerable cloudy swelling of the epithelial cells is seen. In the *hepatic sections* the central areas of the lobules show complete fatty degeneration and even necrosis of the parenchyma cells. Between the lobules small, round celled subacute inflammatory foci are visible. The inner head of the *gastrocnemius* shows no minute changes, the striation of the fibres is very distinct, the nuclei well defined and well stained; in fact there are no signs of a degenerative process. The degenerative changes in the *peroneal nerve* and branches are moderate in degree but are characteristic. There is irregularity of the myelin sheath, swelling, rarefaction, and vacuolation.

Case No. 3.—Acute pernicious beriberi.—Necropsy No. 1619, January 20, 1906: Gregorio Flores, 26 years old, a Filipino prisoner in Bilibid, under a death sentence, was admitted January 18, 1906, to the prison hospital. He complained of weakness and shortness of breath. On admission at 8 a. m. his temperature was 36°.8 C.; pulse, 132; respiration, 32. During the afternoon the temperature rose to 37°.5 C. A urine examination on the morning of January 19 showed specific gravity 1,018, acid reaction; albumen present in small amount, some leucocytes and red-blood corpuscles. At 8 p. m. on January 19 the temperature was 38° C. At 8.20 p. m. the patient suddenly died.

AUTOPSY forty-eight hours after death: Body of a medium-sized, fairly well-nourished native. Post-mortem rigor well marked. Post-mortem lividity over the dependent parts of the body and around the neck Skin somewhat cyanotic. On section, a considerable amount of a dark, fluid blood issues from the superficial veins. The muscular tissue is fairly moist and of a good pink color. The muscles of the calves are very soft and flabby. There is no marked œdema of the subcutaneous connective tissue. The abdominal cavity contains a small amount of clear fluid, but the pericardial fluid is markedly increased. *Heart:* The pericardium is normal. The epicardium, smooth; it shows a few small petechiæ. Myocardium somewhat hypertrophic, especially the right ventricle. Heart muscle

of fair consistency; somewhat grayish-pink but without any signs of marked fatty or parenchymatous degeneration. Coronaries, highly injected. Weight of heart, 315 grams. *Lungs:* the pleuræ are smooth. The anterior surfaces of the lungs are rather pale, purplish-pink; the posterior surfaces are dark purple. A few subpleural ecchymotic spots are noticeable. The lungs are inflated, very heavy and highly œdematous. The mucosa of the trachea and bronchi is somewhat swollen, highly œdematous, and the bronchial tree contains a considerable amount of a thin, somewhat blood-tinged, foamy liquid. *Larynx* normal, with the exception of hyperæmia of the mucosa, particularly of the epiglottis. Tonsils, uvula, etc., normal. *Spleen:* somewhat enlarged, firm in consistency; on section, dark brown-red. Trabeculæ, distinct; follicles, obscure. The *kidneys* are both distinctly small, the right one larger than the other. They are pinkish-gray in color; capsules smooth, peeling off easily. On section, their surfaces present moderately congested vessels. Relation of medulla to cortex, normal; tubules decidedly grayish-white; pyramids quite dark in consequence of vascular congestion. Pelves very small, the left one contains a few drops of a creamy, yellowish, purulent fluid. Ureters, normal. Prostate, normal. The *bladder* is small and almost as solid and muscular as a uterus. Its muscularis measures almost 1 centimeter in diameter, mucosa likewise thick, corrugated, somewhat hyperæmic, but otherwise normal. The organ contains a very small amount of turbid urine. The ureters and the testicles are normal, but the prepuce is long and its opening is not larger than a small pin head. The skin covering the glans penis resembles a delicate mucous membrane. The inner surface of the prepuce is covered with desquamated epithelium. The *liver* is normal in size, capsule smooth, external surface somewhat mottled. On section, interlobular vessels and capillaries much injected; rows of liver cells, pale gray. *Gall-bladder* wall quite œdematous. *Stomach* and *intestines:* normal except that the mucosa of the small intestine is very hyperæmic. *Brain:* normal; weight, 1,270 grams.

ANATOMICAL DIAGNOSIS. *Hydropericardium, moderate hypertrophy of the myocardium, subepicardial and subpleural petechiæ, enlargement and cyanotic induration of the spleen; parenchymatous nephritis, hypertrophy of the muscularis of the urinary bladder, congenital phimosis, moderate chronic passive congestion of the liver. Acute beriberi.*

MICROSCOPICAL EXAMINATION. In the *myocardium* the striation of the cells is generally very indistinct and in places completely obliterated; fine vacuolation is frequently seen and fragmentation is very pronounced. There is also some increase in the interstitial connective tissue. In the *pulmonary sections* the most marked histological change is found in the alveoli, many of which are more or less completely filled either with a granular, or a homogeneous, coagulated material, (serious exudate, coagulated by the fixing process). Some of the air spaces also contain red blood corpuscles. The *spleen* shows considerable increase in connective tissue and some proliferation of the pulp endothelia. In the *renal tissue* the epithelia of the convoluted tubules generally show cloudy swelling. The intralobular capillaries of the *hepatic sections* are injected, the parenchyma cells in the central part of the lobule show fatty changes. The interlobular connective tissue exhibits some small, round cell periportal inflammatory areas. In transverse sections of the wall of the *urinary bladder* it is found that the muscularis is not only very much thickened as a whole but that the individual muscle fibers are considerably hypertrophied, so that many measure in length from 200–250 μ. Sections of the gastrocnemius show no marked changes. The peripheral nerves (the popliteal and its branches), examined both in transverse and in longitudinal sections, show advanced degeneration of the myelin sheath, consisting of irregularities, "rosary swelling," and rarefaction. In places there is loss of the sheath.

Case No. 4.—Acute, pernicious beriberi. Necropsy No. 1068, February 20, 1906: Andres Rabamontano; residence, 346 Cabildo; native Filipino, 18 years old; died quite suddenly at 11 a. m. February 19, 1906, without any previous illness.

AUTOPSY twenty-four hours after death: Body of a strong, muscular native. The post-mortem rigidity is still marked, but it is less strong in the upper than in the lower extremities. Post-mortem lividity well marked, particularly on the dependent parts and around the neck. The face is somewhat puffed, the thorax and sides markedly œdematous; however, there is no appreciable œdema of the lower extremities. On section, the superficial veins discharge a large amount of dark, fluid blood. The subcutaneous tissues of the thorax and, to a lesser extent, those of the abdominal walls are œdematous. The pericardium contains about 300 cubic centimeters, the abdominal cavity about 400–450 cubic centimeters of a clear, straw-colored, serous fluid. *Heart:* The myocardium is hypertrophic, the wall of the right ventricle has a diameter of about 0.6 centimeter, its walls are of a pink color with a few grayish-yellow spots. It weighs 340 grams. *Lungs:* congested, œdematous, increased in consistency, and on the cut surface rather dark brownish-red in color. *Spleen:* capsule very tense, grayish-reddish-purple color; cut surface, brown-red; pulp, rather firm, does not protrude; follicles and trabeculæ, distinct. *Kidneys* and *liver:* much congested, somewhat increased in consistency, otherwise normal. Gall-bladder wall, highly œdematous; its mucosa swollen. Gastric and duodenal mucosa, moderately hyperæmic. Otherwise all internal organs normal. *Nerves* and skeletal muscles show no macroscopic changes.

ANATOMICAL DIAGNOSIS.—*Hydropericardium, hypertrophy of the myocardium, œdema, congestion and cyanotic induration of the lungs, congestion of the spleen, kidneys, and liver, ascites, œdema of the subcutaneous connective tissue. Acute pernicious beriberi.*

MICROSCOPICAL EXAMINATION shows fragmentation of the *myocardium* (otherwise the fibers are perfectly normal), cloudy swelling and fatty degeneration of liver parenchyma cells; and subacute interlobular inflammatory foci. The *popliteal* and *peroneal nerves* show a minor degree of degeneration of the myelin sheath. (The nerves in this very acute pernicious case were removed, handled, and fixed with great care, so that the changes noticed are not due to artefacts.)

Case No. 5.—Acute, wet beriberi with splenomegaly.—Necropsy No. 1225, January 28, 1905: Examination seventeen hours after death in Bilibid Prison morgue of the body of Placido Bajian, Visayan, 34 years old. The patient had been previously working with a gang of prisoners at Fort McKinley. A few days before his death he had been returned on account of sickness to the prison hospital. *Clinical diagnosis: Wet beriberi. Pulmonary œdema.*

AUTOPSY.—Body of a strong, well-nourished native, post-mortem rigidity well marked; post-mortem lividity present over dependent parts. The skin over the entire body is slightly œdematous and pits on pressure. On section the subcutaneous tissue discharges a small amount of serous fluid. The muscles are quite pale and moist. Both the thoracic and abdominal cavities contain a few ounces of slightly cloudy, serous fluid. *Pericardium:* smooth, transparent, contains a somewhat increased amount of fluid. *Heart:* somewhat enlarged in all of its dimensions, epicardium, smooth and transparent, subepicardial fat very moderate in amount. Myocardium, soft and flabby. Both auriculo-ventricular openings enlarged in diameter; the cavities contain chicken-fat coagula and dark, fluid blood. *Endocardium:* smooth, all valves normal, no atheromatous spots in aorta. Color of myocardium, pale, pink, grayish-yellow, cut surface dull. Weight of heart, 325 grams. *Lungs:* pleural surfaces, smooth, few old fibrous adhesions on the lower lobe of the left side; when inflated, pale-grayish-pink except the posterior surfaces

of the lower lobes, which are purplish-blue; in general they contain much serous fluid, the lower lobes much dark blood. Bronchial and tracheal mucosa, smooth and pale. Bronchial glands not enlarged. Spleen very large, weight 910 grams, general configuration that of a normal spleen. Capsule, smooth, tense, not wrinkled; in general, transparent, except over the left half of the upper surface where it is nontransparent, grayish-white, considerably thickened. Pulp, moderately soft, dark brown-red, cut surface smooth. Trabeculæ, quite distinct, broadened; follicles, fairly distinct. *Kidneys* of normal size, capsules smooth, peel off easily. External color, bluish purple; cut surface, dark, pinkish-purple; vessels, much injected; tubules of cortex grayish-white; pyramids rather pale. Relation of cortex to medulla, normal; pelves, normal; ureters and bladder, normal. Suprarenals, small, rather hard, dark brown yellowish. *Liver:* large, greatly congested; externally purplish; on section, brownish-yellow; acini, distinct; interacinous connective tissue possibly somewhat increased. *Gall bladder* and *ducts:* normal. The former contains a considerable quantity of dark, greenish-yellow bile. *Pancreas:* normal. *Stomach* and *intestines:* normal, with the exception of considerable congestion of the gastric veins and a marked hyperæmia of the gastric mucosa. Intestinal mucosa in general pale, except that of the rectum, which is somewhat hyperæmic. No amœbic ulcerations. Scrotum much distended. The left side contains a hydrocele enclosing about 50 cubic centimeters of a straw-colored, serous fluid. On the right side, the testicle is surrounded by a fibrous mass about 0.6 to 1 centimeter in diameter. The fibrous tissue is very tough and is continuous with the tunica albuginea. The testicle contained in this fibrous mass is small, but appears otherwise normal and not atrophic. *Brain:* the dura mater is quite tense, amount of cerebro-spinal fluid, large; brain pale but œdematous, ventricles contain an increased amount of fluid. Otherwise the brain is normal. Weight, 1,335 grams.

ANATOMICAL DIAGNOSIS. *Moderate hypertrophy, dilatation and fatty degeneration of the myocardium, œdema of the lungs, splenomegaly and perisplenitis, congestion of the liver, hydrocele of the left side, chronic fibrosis of the right tunica albuginea, general anæmia, general, moderate œdema. Chronic or subacute, wet beriberi.*

Smears from the spleen show neither malarial parasites nor the Leishman-Donovan bodies.

MICROSCOPICAL EXAMINATION.—*Myocardium* striation quite distinct, no well-marked evidences of fatty degeneration; fragmentation and segmentation pronounced. *Lungs:* inter alveolar septa broadened, many alveoli contain considerable granular and coagulated serous material. There is marked vascular congestion. *Kidneys:* considerable cloudy swelling of uriniferous epithelia. *Spleen:* much increase in connective tissue, particularly of the trabeculæ; very little, if any, endothelial proliferation; crowding of the pulp spaces with blood elements; moderate amount of pigment, no malarial parasites or Leishman-Donovan bodies. The liver in this case, aside from great congestion, fatty degeneration of parenchyma cells, and a moderate amount of pigment, shows subacute interlobular periportal inflammatory foci. The other organs examined (the stomach, pancreas, suprarenals, testicles) show nothing abnormal. The popliteal nerve and branches show the typical degenerative changes of the myelin sheath and axis cylinders.

Case No. 6.—Acute, wet, beriberi complicated by malaria.—Necropsy No. 1190, May 23, 1905: Eustaquio Alvarez, a prisoner of Bilibid, 28 years old, native Visayan, was suddenly taken seriously ill on May 21, 1905, and was admitted to the hospital during the night of May 22, with a temperature of 37°.5. The following morning at 8 o'clock his temperature was 36°.9. He complained of shortness of breath and weakness. On examination the pulse was weak, soft,

easily compressible, and 100 beats per minute. After the patient had walked about the room for a short time it increased to 141. The heart's area of dullness was increased downwardly and to the right, and a systolic bruit could best be heard at the base of the organ. The lower extremities were somewhat œdematous, the skin pitting slightly on pressure. There was no pain complained of in the calves. The patellar reflex on the left side was normal, that on the right accentuated. On May 22 the condition of the patient became worse, the difficulty in respiration increased, and the temperature at 8 o'clock in the evening had risen to 39°. He died at 2.30 a. m. on the next day.

AUTOPSY, eight hours after death.- Body of a strong, well-nourished native, no deformities, medium weight, apparent age 25 to 30 years. Post-mortem rigidity very marked, involving extremities, jaws and the muscles in general. Post-mortem lividity present in the dependent parts of the body. The lymphatic glands are not palpable. On section, the superficial vessels discharge a considerable amount of dark, fluid blood and the subcutaneous connective tissue is found to be œdematous; the muscles are quite moist. The pleural cavity contains a few ounces of clear, straw-colored serum. Both pleuræ show a number of petechiæ. The *lungs* in general form are normal and of pinkish-gray color. They are inflated. On section, the blood vessels are found to be congested and a large amount of watery fluid can be pressed out of the tissues. The trachea and bronchi are normal but the epiglottis shows a few petechiæ. *Heart:* the pericardium contains a somewhat increased amount of clear, serous fluid. The myocardium exhibits a few spots of subepicardial hæmorrhages; it is of normal consistency. The right side is considerably dilated, markedly hypertrophied, and the whole heart weighs 360 grams. It contains dark, fluid blood and gelatinous clots. The muscle is pink in color, with a few grayish-yellow spots. The coronary vessels are tortuous and distended. The abdominal cavity contains about 300 cubic centimeters of straw-colored, clear fluid. The mesenteric and post-peritoneal glands are not enlarged. The *spleen* weighs 540 grams. It is very soft, dark grayish-purple externally and on section dark brownish-black. The pulp is very soft and protrudes over the surface. The trabeculæ and the Malpighian bodies are not distinct. The *liver* is normal in size, somewhat increased in consistency, surface smooth, externally reddish brown. On section its vessels discharge a considerable quantity of dark, fluid blood. The gall bladder, which contains about two to three dozen small, very dark stones, is normal except that its walls are very œdamatous. The *kidneys* are normal in size, their surface is smooth, dark grayish-pink in appearance, consistency rather soft, capsules peel off easily. On section the vessels appear moderately congested, the surface is rather dull, tubules grayish-white. Ureters, bladder, pancreas, etc., normal. The stomach and the intestines show nothing abnormal. Their mucosa is rather pale-gray as far as the stomach is concerned, but hyperæmic in the small and large intestines. The *brain* is normal but quite œdematous. The ventricles contain about 30 to 50 cubic centimeters of clear fluid. The peripheral *nerves* show no changes.

ANATOMICAL DIAGNOSIS.--*Dilatation of the right side of the heart, moderate general hypertrophy of the myocardium, œdema of the lungs and of the brain, moderate general anasarca, acute, parenchymatous nephritis, congestion of the liver, colelithiasis, enlargement, pigmentation, and softening of the spleen. Acute, wet beriberi (complicated, as shown by the microscopical examination, with æstivo-autumnal malaria).*

MICROSCOPICAL EXAMINATION.- *Myocardium:* the fibers, aside from fragmentation, show no changes. The nuclei are well stained and clear cut. Striation of the sarcoplasm is very distinct. In the lungs, the blood vessels are dilated

and congested. Here and there the connective tissue of the intra-alveolar septa is increased. Many of the alveoli contain desquamated cells and granular detritus. In the *spleen* the pulp spaces are much crowded with red blood corpuscles, among which are a moderate number of leucocytes. The follicles are not sharply defined, the trabeculæ are thin, the connective tissue in general is not increased. Both in the pulp spaces and in the follicles a considerable amount of extra- and intracellular dark-brown pigment is encountered. Parasites of æstivo-autumnal malaria are fairly numerous. In the *liver*, the interlobular capillaries are dilated and filled with blood. The parenchyma cells show some fatty and well-marked cloudy changes. The most prominent histologic deviation from the normal type is found in the interlobular connective tissue. Here we see a periportal inflammatory infiltration composed of small, round lymphoid cells, some ordinary polynuclear and quite a few eosinophilic cells. Fine, dark, pigment granules are seen all through the hepatic sections while the interlobular foci also show coarser pigment granules. In these foci malarial parasites are likewise encountered. The renal sections show cloudy swelling of the tubular epithelia, with much granular material; otherwise there are no marked changes. In the *stomach*, the mucosa, which is otherwise normal, shows a moderate eosinophilia. In the mucosa of the *small intestine* very large numbers of polynuclear eosinophiles are present. These cells are found throughout the mucosa; they extend into the muscularis mucosæ and into the surrounding, loose connective tissue. The popliteal nerve and its branches show but a very moderate degree of degeneration of the myelin sheath, but some is undoubtedly present.

Case No. 7. Acute beriberi complicated by malaria. Necropsy No. 1674, March 7, 1906. Post-mortem examination at St. Paul's Hospital on the body of Okumura Kakuzo, a Japanese, 18 to 20 years old. This man had been under observation while sick at the hospital for two or three days. Absence of the patellar reflex, paresis of the lower extremities and dyspnœa had been noted. A blood examination showed malarial parasites of the æstivo-autumnal type. A few ova of *uncinaria duodenale* were found upon examination of the stools. *Clinical diagnosis, beriberi complicated by malaria.* The patient died March 6 at 8.30 p. m.

AUTOPSY.—Twenty hours after death: The body is that of a well-developed, rather strong Japanese, well nourished, no anomalies. The anterior tibial surfaces of the legs show a few, shallow cicatrices. *Rigor mortis*, well marked. Posterior surface of the body shows extensive areas of lividity. The important lesions observed may be summarized as follows: The pericardial fluid is increased, the *heart* is hypertrophied, and the wall of the right ventricle has a thickness of from 6 to 8 millimeters. The consistency of the myocardium is normal; the color is pink, with a few yellowish spots. The *lungs* are œdematous, but otherwise normal. The *spleen* weighs about 450 grams. It is dark, purplish-gray externally, and on section, of a light-reddish-brown color. The pulp is very soft and protrudes over the cut surface. Follicles and trabeculæ are not easily distinguished. The *liver* is large, swollen, grayish-pink in color with numerous yellow dots. On the cut surface it is dull grayish-pink and the veins discharge a considerable quantity of blood. The kidneys are normal in size, the capsules peel off easily, and the cut surface shows a peculiar rose or pink color. The mucosa of the stomach and duodenum is moderately hyperæmic. Otherwise the internal organs are normal. No uncinaria are found in the small intestine.

ANATOMICAL DIAGNOSIS.—*Moderate hydropericardium, hypertrophy of the myocardium, œdema of the lungs, enlargement, congestion and softening of the spleen, hyperæmia of the kidneys, congestion, fatty and parenchymatous degeneration of the liver, hyperæmia of the gastric and duodenal mucosa, acute pernicious beriberi.*

During the post-mortem examination, two agar tubes were inoculated from the cerebro-spinal fluid obtained by puncture with a sterile syringe at the third lumbar vertebrae. Another tube was inoculated from the heart's blood and pieces of the wall of the stomach and of the duodenum with some gastric contents were placed in a flask containing several hundred cubic centimeters of alkaline bouillon. The bouillon was then heated to 80° C. and kept at that temperature for about ten minutes. It was then cooled in the refrigerator and subsequently incubated. (Experiments with these cultures are reported above.)

MICROSCOPICAL EXAMINATION.—The *myocardial* fibers are a little hazy in striation and here and there finely vacuolated. Fragmentation is pronounced. The *splenic sections* show some increase in connective tissue, considerable endothelial proliferation, and pigment, and a number of malarial parasites. Pigment and malarial parasites are also found in the *liver sections* which also show somewhat extensive acute inflammatory interlobular foci. There is some granular degeneration of the parenchyma cells. The sections from the *stomach* and *duodenum* show nothing abnormal. Those of the nerves reveal advanced degenerative changes.

Case No. 8.—Subacute, wet beriberi.—Necropsy No. 913, March 7, 1904 (history kindly furnished by Dr. G. B. Cook): Antonio Ybalio, a Filipino, policeman, 36 years old. *Previous history:* Patient was ill in Civil Hospital from January 17 to 30, 1904, and was treated for amœbic dysentery. At this time he complained of insomnia, pain in the abdomen, slight cough, and moderate fever (37°.7). There was no anasarca present. Amœbæ and ova of *Trichocephalus dispar* were found in his stools on January 18. Treatment with quinine enemata was instituted, under which he improved, leaving the hospital on January 30, 1904. The report of the stool examination at this time was negative for amœbæ. *Present illness:* On February 28, 1904, he again entered the hospital stating that he had not been well since his illness in January, but during this time had become weaker and weaker, swelling of his legs had developed, and he had suffered, in addition, with pain in the abdomen, anorexia, dyspnœa, insomnia, difficulty in locomotion, and constipation. His temperature was subnormal throughout his present illness until just before he died, when it registered 37.7°. *Physical examination:* Expression heavy, face swollen, respiration labored; general anasarca especially marked in feet and legs; abdomen, distended and painful on pressure. Pain was elicited on pressure over tibiæ. Apex beat, forcible and displaced to left of normal position about 2 to 2.5 centimeters. A double murmur of a blowing character could be heard most distinctly at the apex. The reflexes were not tested. *Course of illness and treatment:* On admission he was given Liq. potass arsen. *gtts.* 6 three times daily, nourishing diet, and a cathartic of magnesium sulphate when necessary. On March 1 the urine examination was as follows: Specific gravity, 1.023; acid; small amount of albumen; urea, 20.46 grams per liter; sediment slight, very many hyaline and a few granular casts. After receipt of this report the diet was restricted; Fowler's solution omitted and infusion of digitalis and lithium citrate given. His condition steadily grew worse and he died on March 6, 1904, at 11.30 p. m.

AUTOPSY fourteen hours after death: Body of a well-developed Filipino, about 35 to 40 years old. Post-mortem rigidity and lividity well marked. The integument is quite œdematous, particularly over the abdomen, the anterior surface of the legs and at the dorsum of the feet, where the skin pits on pressure. The scrotum is œdematous and swollen to about two to three times its normal size. On both legs and forearms small, symmetrically placed pin-head sized petechiæ are visible. The scleræ are somewhat icteric. On section, the veins discharge a considerable amount of dark, fluid blood. The subcutaneous

connective tissue is œdematous, in places even gelatinous. On opening the spinal canal and the cranial cavity, the dura is found to be tense, the amount of cerebro-spinal fluid increased. The vessels of the pia-arachnoid are injected, and the brain itself is rather œdematous; fluid in the ventricles is increased; otherwise, the brain and the cord are normal. The thoracic as well as the abdominal cavity contains a moderate amount of clear, straw-colored fluid. *Pericardium:* smooth, glistening, translucent, distended by an increased amount of clear, serous fluid; probably three to four times as much as normally found. The *heart* is large, soft, and flabby; dimensions, 16 centimeters from base to apex, 12 centimeters from side to side, 7.5 centimeters from before to backward. Visceral pericardium, smooth; coronary veins much injected, deep-bluish-purple in color; both auriculo-ventricular openings somewhat enlarged. Auriculo-ventricular valves on right side not quite competent. Endocardium, smooth except over the aortic valves. These are markedly thickened, somewhat nodular, and slightly retracted toward their peripheral attachment. However, there are neither loss of substance nor any adhesions. Beginning of aorta, atheromatous. *Lungs:* adherent by old fibrous adhesions, which are difficult to separate. Adhesions present at the apices as well as at the diaphragmatic surfaces. Purplish-gray in color at the upper lobes, quite deep purplish at the lower ones. On section, much blood and œdematous fluid escapes. The lower lobes in particular contain a considerable amount of dark, fluid blood and very little air. The bronchi contain frothy mucus. Mucous membranes of trachea and bronchi, somewhat injected and swollen. *Spleen:* 10 by 8 by 5 centimeters. Capsule, on the whole, smooth though slightly wrinkled; pinkish-red; on section, dark-brown. Trabeculæ, well marked; pulp, fairly soft, somewhat protruding. *Kidneys:* 11.5 by 6 by 5 centimeters; pinkish-reddish-purple; after removal of capsules, which strip off easily, areas of a more grayish color are seen. On section, cortex 3 to 9 millimeters; vessels, injected; tubules, grayish-yellow; pyramids, dark brownish red, much injected. Mucous membrane of pelves, smooth; suprarenals, swollen, enlarged, quite soft, dark-purple in color. *Liver:* rather small, pinkish-gray; capsule, smooth, translucent; center of lobules appear as rather pale, shiny grayish areas. On section, color is in general rather dark pink-purplish mixed with grayish yellow. Vessels contain much dark blood. *Gall bladder:* distended with turbid, dark green bile; mucous membranes, smooth, no stones. *Pancreas:* large, rather soft; otherwise normal. *Stomach:* serosa smooth, shining, transparent; veins much injected, particularly those radiating from the lesser curvature; gastric mucosa thrown into prominent rugæ, much congested, of a pale, pink color with a hue of purple. Oesophageal mucosa, likewise, though more moderately, injected. *Intestines:* the serosa is markedly injected over the whole length; the process is more marked in the serosa of the small intestine. *Duodenum:* mucosa, somewhat swollen; vessels, injected, pinkish-red in color. The mucosa of the jejunum and ileum is likewise injected, though less than that of the duodenum. Peyer's patches distinctly swollen. Appendix, normal. Large intestines, practically normal except slight injection of the mucosa.

Anatomical diagnosis.—*Hydropericardium, dilatation and hypertrophy of the myocardium, chronic endocarditis of the aortic valves, atheromatosis of the aorta, congestion and œdema of the lungs, hyperæmia of the gastric and intestinal mucosa, parenchymatous degeneration of the kidneys and liver, enlargement and chronic congestion of the spleen, hydrothorax, ascites, general œdema of the subcutaneous connective tissue. Subacute, wet beriberi.*

Microscopical examination.—*Myocardium:* striation of fibers in places completely lost; fine and coarse vacuolation; granular degeneration very pronounced;

fragmentation well marked in some places; many poorly stained nuclei. Pulmonary alveoli contain much granular material; interalveolar capillaris, distended and densely filled; peribronchial and perivascular connective tissue somewhat increased. *Spleen:* increase in connective tissue, considerable; proliferation of pulp endothelia. *Kidneys:* tubular epithelia show cloudy swelling of a moderate degree and extent. Here and there, granular material in tubules. Otherwise, no changes. The *liver* in some parts shows great congestion of intralobular capillaries with fatty and granular degeneration, necrosis of parenchyma cells and interlobular, subacute inflammatory foci; in other parts, an advanced necrosis and atrophy of parenchyma cells of the central areas of the lobules is seen. The *gastric* and *intestinal mucosa*, aside from vascular congestion, shows no marked changes. The *popliteal nerve* and branches show advanced degenerative changes and a marked increase in the neurolemma nuclei; however, no inflammatory changes of any kind are present.

Case No. 9.—Subacute, wet beriberi.—Necropsy No. 1536, November 17, 1905: Agaton Caber, 24 years old, male Filipino, prisoner at Bilibid, died November 16 at midnight.

AUTOPSY twelve hours after death: Body of a strong, young male Filipino. Post-mortem rigidity and lividity well marked. The whole surface of the body is œdematous; this is most marked at the lower extremities, where the skin pits on pressure. On section, the subcutaneous areolar tissue discharges a considerable amount of a clear, serous fluid. The muscles are moist and of a rather pale-pink color The *pericardium* is smooth and shiny, tensely expanded, and contains an increased amount of clear, amber-colored pericardial fluid. The *heart* is moderately enlarged. There is hypertrophy with some dilitation of the right ventricle. Both sides contain chicken-fat clots; the tricuspid opening is somewhat enlarged. The endocardium and the epicardium are smooth and otherwise normal. The myocardium is of very fair consistency, dull-pale-pink in color. The heart weighs 340 grams. *Lungs:* The pleural sacs contain an increased amount of clear fluid; the pleuræ are smooth, they show a very few small, subpleural petechiæ. In general, the external color of the lungs is of a pink-purple, except on the posterior surface of the lower lobes, where the color is a deep bluish-purple. The lower lobes, on section, discharge much dark blood; the upper ones are very œdematous. The pulmonary tissue is comparatively poor in air. The bronchial glands are normal, the bronchi contain a considerable amount of a thin, foamy fluid. The *spleen* is enlarged to about twice its normal size; capsule, of a steel-blue color, very tense. The pulp protrudes slightly on section. It is moderately soft, and much congested; trabeculæ, enlarged; follicles, fairly well visible; color, dark-brown. *Kidneys*, normal in size; capsules, smooth, pink-purplish with grayish-yellow mottling. On section, tubules grayish-white, vessels moderately injected; relation of medulla to cortex, normal; pelves, normal, capsules peel off easily; suprarenals, small, œdematous, quite intensely pigmented; bladder, etc., normal. *Stomach* and *duodenum*, serosa slightly hyperæmic; mucosa, markedly so, otherwise nothing abnormal. *Jejunum* and *ileum*, serosa and mucosa hyperæmic, intestinal wall as a whole somewhat œdematous. Large intestine, normal. The peritoneal cavity contains a considerable amount of clear, straw-colored fluid. The *liver* is somewhat swollen; capsule, smooth, tense, dark-purplish-blue. On section, liver lobules indistinct, yellowish mottling. Vessels discharge much dark fluid blood. Brain, œdematous, otherwise normal. Weight, 1,385 grams.

ANATOMICAL DIAGNOSIS.—*Moderate hypertrophy of the right side of the heart, œdema of the lungs, moderate fatty degeneration of the kidney and liver, enlargement of the spleen, hyperæmia of the gastric and intestinal mucosa, œdema of the brain, general moderate anasarca. Subacute, wet beriberi.*

MICROSCOPICAL EXAMINATION.—The *myocardial* fibers show a fairly distinct striation and some fine, dust-like vacuolation. Nuclei, well stained, fragmentation present to a moderate extent, interstitial connective tissue somewhat increased. The pulmonary interalveolar capillaries and the vessels of the *lungs* in general are congested; the alveoli partly filled with a cellular and serous exudate; the peribronchial connective tissue here and there somewhat increased. In the *spleen* the connective tissue is much increased and the pulp spaces are crowded with blood cells; outlines of follicles, indistinct. The tubular epithelia of the kidneys show cloudy swelling and fatty degeneration, but in general only in moderate degree. The *hepatic sections* show congestion of the intralobular capillaries, fatty degeneration of the cells in the center of the lobule and interlobular, periportal, subacute, inflammatory foci. A pronounced eosinophilia is found in the mucosa of the stomach and of the duodenum. The degenerative changes in the popliteal nerve and its branches are well advanced.

Case No. 10.—Subacute beriberi complicated with malaria and amœbiasis.—Necropsy No. 1636, February 1, 1906 (history kindly furnished by Dr. G. B. Cook). Donoso Coronel, a native Filipino of 45 years, light-house keeper in Manila Bay, assumed the duties of his position some time in December, 1905. Seven days after going to work in the light-house (according to the statements of the patient, who appears to be quite dull mentally) he became sick, but remained in the light house for three more weeks, when he finally entered the Civil Hospital. On admission, patient could not walk on account of partial paralysis of the legs; his expression was heavy and he complained of pain in the abdomen; lower eyelids, puffy, and lower extremities, œdematous, pitting on pressure. Pulse, 114, apex beat displaced outward and downward, the second sound at the apex is prolonged and the second pulmonic sound is accentuated. There is visible pulsation in the upper epigastric region. The patient complains of pain in the abdomen and in the muscles of the legs and forearms. There is decided pain on pressure of the calves. The legs are moved slowly and with difficulty, extension of the feet and legs is weak; there is no ankle or wrist drop; the patellar reflexes are absent. On admission, the temperature registered 38.5°. Æstivo autumnal malarial parasites were found in the blood and amœbæ in the stools. On January 26 the patient was examined by the writer, who found all of the more typical symptoms of subacute, wet beriberi. Some of the blood of the patient was drawn from the median cephalic vein and used for incubation and for animal experiments (reported above). The patient died February 1, 1906, at 4.20 a. m.

AUTOPSY four hours after death: Native Filipino of medium size and good nutrition. Post mortem rigidity marked; post mortem lividity, beginning to show on dependent portions of the body. The dorsum of the feet and of the legs is slightly œdematous. On section, the superficial veins discharge a considerable amount of dark, fluid blood. The subcutaneous connective tissue is slightly œdematous. The pericardium contains about 100 cubic centimeters of a clear, straw colored serum; the pleural and the abdominal cavities, each several hundred cubic centimeters. The *heart* is considerably enlarged in all of its dimensions. The right auriculo-ventricular opening admits five fingers; the myocardial wall of the right ventricle measures 6 to 7 millimeters in thickness. The left auriculo-ventricular opening admits three fingers, and the myocardium of the left side is likewise hypertrophic. Epicardium and endocardium, smooth and otherwise normal. Myocardium of fair consistency, but pale yellowish-gray. Papillary muscle of left side considerably hypertrophied. *Lungs:* collapsed, poor in air, bound down by some old, fibrous adhesions; externally, grayish-pink with some purple in the lower and posterior parts. They are found to be rather dry on section. The bronchi contain a rather thick, foamy liquid; the mucosa is pale and not swollen; the bronchial glands are normal. The *spleen* is enlarged to

about twice the normal size; it is soft, intensely congested, dark brownish-black; follicles and trabeculæ, distinct. The *kidneys* are normal in size, rather firm in consistency, pinkish-gray externally; capsules, smooth, peel off easily. On section, tubules, grayish-white, slightly cloudy; vessels, congested; pelves, normal; ureters, bladder, etc., normal. The *mucosa of the stomach* is slightly hyperæmic at the apices of the folds; that of the duodenum is likewise hyperæmic. The ducts of the gall bladder are open. *Liver:* swollen, tense, grayish-dark in color; on section, brownish-yellow. The mucosa of the *rectum* and *colon* is hyperæmic and shows a few shallow ulcerations; otherwise, normal.

ANATOMICAL DIAGNOSIS.—*Hydropericardium, hydrothorax, ascites, hypertrophy of the myocardium and dilatation of the right heart; congestion, hypertrophy and pigmentation of the spleen, parenchymatous degeneration of the kidneys and liver. Hyperæmia of the gastric and duodenal mucosa; amœbic ulcerations of the large intestines.. Subacute, wet beriberi.*

MICROSCOPICAL EXAMINATION.—The *myocardium* shows an indistinct striation, fine, with a coarser vacuolation here and there, fragmentation and segmentation and some increase in connective tissue. The pulmonary sections show no pronounced changes. In the *spleen*, a considerable amount of pigment and a moderate number of malarial parasites are seen. The *renal* sections exhibit considerable cloudy swelling of the uriniferous tubules. In the liver there is found congestion of the intralobular capillaries, cloudy swelling and fatty degeneration of parenchyma cells and interlobular, periportal, subacute, inflammatory foci. The stomach and the duodenum do not show any particular changes. In the large intestine there are erosions and ulcerations with leucocytic infiltration of the mucosa. Amœbæ, however, were not discovered in the sections examined. The degeneration of the peripheral nerves is very pronounced, there are irregularities, beaded swellings, honeycombing, and sometimes a complete loss of the myelin sheath.

Case No. 11.—Chronic, dry beriberi.—Necropsy No. 1617, January 19, 1906: Evaristo Rivera, a 35-year-old Filipino, a prisoner at Bilibid, was admitted to the hospital on January 5, 1906. He had been suffering for some time from indefinite symptoms and from muscular pains with some disturbances of motion. His case was first diagnosed as muscular rheumatism. Later on, absence of patellar reflex, enlargement of the heart toward the right side and other symptoms suggested the diagnosis of beriberi. On January 18, 1906, at 8 a. m., the patient exhibited a subnormal temperature of 35.1°, the temperature at noon had risen to 36.3°; pulse 86, respiration 38. At 1.30 p. m. the patient died in syncope.

AUTOPSY twenty-two hours after death: Body of medium-sized, normally developed native, about 30 to 40 years old, poorly nourished. *Rigor mortis:* moderate. Post-mortem lividity well marked on the dependent parts of the body. The surface in general is moderately cyanotic. On section of the body, the superficial veins discharge a considerable amount of dark, fluid blood. The muscles are pale-pink, not very moist. The lymphatics are normal. The pleuræ of the lungs are smooth. The *lungs* are inflated and of a very pale-pink color except in the dependent part where they are light-purple. They are highly œdematous and on section a large amount of watery, foamy fluid escapes. The *heart* is markedly enlarged. It weighs 370 grams; the hypertrophy is particularly noticeable in the right ventricle which is also considerably dilated. Its wall has a diameter of about 7 to 8 millimeters. The chambers contain a considerable amount of dark, fluid blood, and in addition chicken-fat clots. The myocardium is of fair consistency and of a pale, gray-pink color. There are no evidences of marked fatty degeneration. The pericardium and endocardium are smooth; no ecchymoses or petechiae being present. The *intestinal serosa* is rather pale, but translucent; appendix, normal. Mesenteric and post-peritoneal glands somewhat

enlarged. The *spleen* is slightly enlarged, moderately indurated, dark, steel-gray externally and on section, dark brown-red. The pulp is quite firm, the trabeculæ widened and the follicles not very distinct. The *liver* is somewhat increased in size, swollen and of increased consistency. Its capsule is smooth, transparent and translucent. Externally, the organ is of bluish-purple color, with numerous yellow streaks and dots visible through the capsule. The cut surface presents the typical picture of a nutmeg liver. Gall bladder and gall ducts normal. *Kidneys:* normal in size. Capsules, smooth, peeling off easily; external color, pinkish-blue. Consistency of these organs increased. On section, the blood vessels are found to be moderately congested. Tubules are decidedly grayish-white, the pyramids are moderately congested. The *gastro-intestinal tract* is normal except that the mucosa of the small, as well as that of the large intestine, is much congested, so that the veins stand out very prominently. The congestion is best marked in the first part of the duodenum. On dissecting out the *popliteal nerve* and its branches on the left side, it is found that the sheathes show numerous ecchymoses. Such ecchymotic spots also extend into the substance of the gastrocnemius muscle. The muscles of the calf in general are very flabby, and of a pale, grayish-pink color. The brain is very pale, the ventricles contain a moderate amount of fluid; otherwise, the organ is normal. Weight of the brain, 1,165 grams.

ANATOMICAL DIAGNOSIS.- *Hypertrophy of the heart, particularly of the right ventricle, œdema of the lungs, chronic cyanotic induration of the spleen, congestion and parenchymatous degeneration of the kidneys, chronic passive congestion of the liver, congestion of the internal mucosa, ecchymoses into the sheath of the left popliteal nerve and branches, general anæmia, chronic, dry beriberi.*

MICROSCOPICAL EXAMINATION.—The noteworthy changes found in sections of the various organs are: *Myocardium*, no marked microscopic changes, except a moderate increase in the perinuclear pigment. *Spleen*, considerable increase in the connective tissue of the trabeculæ and of the pulp, some proliferation of pulp and endothelia, crowding of the pulp spaces with erythrocytes; follicles, very indistinct and ill-defined. *Kidneys*, cloudy swelling of epithelia of uriniferous tubules; fibrosis and obliteration of some of the Malpighian tufts; however, no general increase of connective tissue; fairly numerous hyaline casts in the tubules. *Liver*, great congestion of the intralobular capillaries, atrophy and fatty degeneration of the parenchyma cells in the center of the lobule. Some round cell inflammatory infiltration of the interlobular connective tissue. Gastrocnemius (inner head), some of the muscle fibers have lost both transverse and longitudinal striation and are swollen and almost homogeneous; however, others are perfectly normal in appearance. *Popliteal nerve and branches*, the degeneration of the myelin sheath and axis cylinders is well advanced.

SYMPTOMATOLOGY.

Clinical types of the disease.—From a clinical standpoint, beriberi may be divided into three main types, namely—the acute pernicious, the wet or œdematous, and the dry or atrophic beriberi; however, this classification is somewhat arbitrary. A rudimentary variety of the disease, in which the symptoms are so mild that medical aid is generally not sought, also frequently occurs in addition to these three well-defined types. Malaise, weakness of the lower extremities, and increased heart beat on slight exertion are usually noticed in these cases. These symptoms may speedily and spontaneously disappear, or they may increase in intensity and then lead to one of the well-defined severer types of the disease.

In the acute, pernicious form, the onset of the symptoms is generally rapid. The patient becomes ill, apparently without premonitory symptoms. A feeling of oppression develops in the chest, dyspnœa, forced respiration, evidences of great venous congestion, frequent vomiting, and the signs of rapid heart failure appear and death finally supervenes. The different types of beriberi have been described by observers from all localities where the disease is prevalent, but they vary in their predominance.

A. Plehn[*] recently observed a number of cases of beriberi in German West Africa (Kamerun); they were all of the acute, pernicious type, ending fatally within from twelve to forty-eight hours. However, he states that Lichtenberg previously had seen subacute and chronic cases in the same territory. Plehn's cases, with one exception which was complicated by malaria, never showed any elevation of temperature; they were characterized by dyspnœa, forced, frequent respiration, violent action of the heart, small, easily compressible, rapid pulse, muscular weakness, and violent vomiting. Death occurred from paralysis of the heart after the pulse had become imperceptible.

Both the œdematous and the atrophic types generally develop in the same manner. Preceding the actual outbreak of the disease there is a period of malaise, during which a dull pain in the stomach, lack of appetite, and a heaviness in the lower extremities and occasionally in the upper ones are complained of.

Wright believes that the incubation period of beriberi is between ten and fifteen days, although extreme paralysis and the other more marked effects of the virus may not manifest themselves until some days after the first demonstrable symptoms of nerve lesions have occurred. One of the earliest symptoms usually referred to by the patient, is palpitation of the heart on slight exertion; next, pain in the legs is frequently noticed, particularly in the calves, which soon become tender on pressure. Later, the gait becomes unsteady; the patient walks as if it were difficult for him to lift his feet from the ground, as indeed it is, the effect being such that this gait has not improperly been compared to that of a man walking in soft and very sticky clay, or to that of a man heavily dressed, who has been in the water and whose clothes are weighted by the amount of fluid absorbed. At this stage, in *wet* beriberi, an œdema of the lower extremities is generally noticeable. It is particularly well-marked over the anterior tibial region, over the dorsum of the feet, and around the ankles. In these places the skin pits on pressure. In the *dry* form there may be slight œdema at an early period in the disease, but this is not well marked and is only transitory in character. The lower extremities in this variety, instead of being swollen, become more and more emaciated, the muscles become atrophic, and often indurated

[*] Plehn: Die acuten Infektionskrankheiten bei den Negern der äquatorialen Küsten Westafrikas. *Virchow's Archiv.* (1903), 174, Supplement (Beriberi, p. 61).

and contracted. Together with the disturbances of locomotion, those of sensation simultaneously develop. Hypæsthesia of the lower extremities is the most common form of disturbance of sensation in beriberi. It generally begins on the anterior, or external, surface of the legs and frequently extends to the dorsum of the feet and toes. In other words, it is found in the regions supplied by the peroneal and saphenous nerves. Accompanying hypæsthesia, there is a subjective paræsthesia. If the skin of the patient is touched with a soft, camel's-hair brush, he has the sensation of paper intervening between the skin and the brush. The intensity and the extent of such sensations not only vary in different individuals but also at different periods of time in the same one. These disturbances have a tendency to extend upward from the feet and legs. In the severer cases, the upper extremities are similary affected. The face is rarely involved, but occasionally disturbances in sensation are found around the mouth. True anæsthesia is rare, as is also hyperæsthesia. The interferences with motility generally begin as a sensation of weakness in the legs, which is first noticed in the calves and later on in the thighs. After these changes have endured for some time, atrophy generally manifests itself, or it may appear even before distinct paralysis becomes obvious. Usually, the anterior, sharp edge of the tibia becomes more prominent, the calf thin and flabby, and the thigh gradually emaciated. When more or less contraction is associated with the atrophy, the foot assumes an equinovarus position. In severe cases, similar changes occur in the upper extremities. Paralysis of the lower extremities is much more common than it is of the upper ones; but in the severest cases both feet and hands, including the toes and fingers, may be paralyzed. In such instances the hands and fingers may occasionally be more affected than the feet. In the gravest types neither the hands nor the fingers can be flexed toward the dorsum, and we have complete wrist drop, as is the case in lead poisoning.

The electrical excitability shows various degrees of change, from a simple diminution to complete degeneration reaction. According to K. Miura,[39] one can predict the result of the electrical reaction from the position and movements of the foot and toes. If the foot can easily be moved on the ankle joint, one finds only a diminution of electrical excitability. If the toes, but not the foot, can be flexed dorsally, we encounter only a partial degeneration reaction, but if neither the foot nor the toes can be moved voluntarily, then it is complete. Paralysis of the diaphragm and of the intercostal muscles occurs only in the severest cases. Other nerves, besides those of the extremities which are so profoundly affected in beriberi, are also more or less frequently involved. Paresis of the muscles of the larynx is by no means rare; in fact, it is a

[39] K. Miura: Notizen zur Symptomatologie der Beriberi. *Centralb. für Neurologie, etc.*, Tokyo, April (1905), 6.

very common occurrence in beriberi to find changes in the voice, such as hoarseness and more or less complete aphonia. Paresis of the facial nerves and of the *nervus abducens* has occasionally been observed, as have also disturbances of the optic nerves, manifesting themselves by central scotoma, and in rare cases by amblyopia. Among the late symptoms of beriberi, which in the advanced disease frequently become quite prominent, are contractions of the muscles, particularly of the gastrocnemius.

If an early examination, both in the hypertrophic and in the atrophic dry types, be made, the following symptomatology may be elicited; the pulse is generally rapid, somewhat irregular, rather weak, and easily compressible. Upon exertion, which may even be so slight as the act of sitting up in bed for examination, the pulse rate increases 20 to 30 beats a minute. At times, quite early in the course of the disease and frequently later, after if has existed for several days, the apex of the heart is found to be displaced upward and outward and the area of visible heart beat to be enlarged. Percussion shows an extension of the area of heart dullness toward the right and frequently even to the right of the sternum. Where there is hypertrophy of the left ventricle the area of dullness is also increased to the left. Auscultation at the apex of the heart frequently reveals some changes in the systolic sound, but the most common alteration observed in beriberi generally is a marked accentuation of the second pulmonic sound. At times a definite, systolic bruit may be heard at the apex; frequently a reduplication of the second sound both at the apex and at the pulmonary valves exists. A considerable number of cases of beriberi also reveal a musical sound which may be heard over the crural arteries as was first prominently pointed out by M. Miura.[40] This observer in some cases reported the sound to be audible even at a distance of several feet from the vessel. In the early stages of beriberi, sometimes up to the sixth or seventh day of the disease, the patellar reflex is increased; then a diminution develops, and finally it becomes entirely absent. Even in cases which terminate favorably, the absence of the patellar reflex may last for a long time and may still be noticeable after the disturbances of locomotion have disappeared. When the knee jerk begins to reappear, it then generally once more becomes temporarily accentuated, finally returning to the normal.

Durham makes the following statements with reference to the patellar reflex in beriberi:

Too little notice is, I think, taken in most books of the preliminary exaggeration of the knee jerk, which so commonly precedes the loss thereof. Whether the knee jerk is ever lost without a previous stage of increase I am not able

[40] M. Miura: Der diastalische Arterienton. *Zeitschr. d. Mediz. Ges. zu Tokyo*, Jan. (1891), and *Mittheil. d. mediz. Fakultät, Univ. zu Tokyo* (1898), No. 2, 4, 71.

to say, but observations of a number of patients showed that, given the increase, it may remain and never disappear before the patient's apparent recovery, or it may slowly decrease to absolute loss, or it may disappear rapidly in a few days, giving way to complete absence. Recovery of the knee jerk after loss seems to be a very slow process, but that it is eventually regained there can be no doubt, if the history of having had the disease in several prisoners and others is to be believed. Increased response to a blow of the muscles seems to obtain generally after the diminution of knee jerk has occurred.

It has already been mentioned that the muscles of the calves of the leg are frequently painful and very tender to pressure. The skin, particularly of the lower extremities, shows disturbances of sensation. There is general hypæsthesia or paræsthesia and less frequently complete anæsthesia. In mild cases the urine is somewhat decreased in amount, and in severe ones considerably so. The diminution is sometimes very great and the daily amount passed may fall below 100 cubic centimeters. The specific gravity in such cases is increased, but not proportionately to the great diminution in amount. Albumen is generally not present. However, when it is observed, only traces occur. Sometimes, though rarely, a complicating nephritis develops in the later stages of beriberi and then albumen is constantly found in the urine. Indican is very frequently observed in the urine in the acute and œdematous varieties of the disease.

According to most authors, the *temperature* in uncomplicated cases of beriberi is either normal or very slightly elevated. Whenever we have met with a fatal case of this disease, in which there was, *inter vitam*, a marked rise in temperature, on post-mortem examination we have found some complication, generally either amœbic dysentery or malaria. In cases of the œdematous or of the atrophic form, which progress unfavorably, the dyspnœa and the difficulty in respiration increase and the resulting, grave circulatory disturbances find their expression in a superficial venous congestion, with visible, throbbing veins. While consciousness is preserved, the dyspnœa and the suffering, progress, and the face of the patient sometimes presents a picture of grave anxiety, such as may be seen in true angina pectoris (arteriosclerosis of the coronary arteries), and death frequently occurs quickly in consequence of heart failure.

Stanley[41] has drawn attention to the frequency of *sudden heart failure* in diphtheria and in beriberi. His analysis of 341 cases of the latter disease shows 72 fatal ones, of which 31 died of rapid heart failure. The pulse tension was lowered in 254 cases, and dilatation of the heart existed in 98. The second sound was reduplicated in 215 and the first

[41] Arthur Stanley: On Sudden Heart Failure in Toxæmic Conditions with a Special Reference to Diphtheria and Beriberi. *Brit. Med. Journal*, (1903), 2 1036.

in 35. There were cardiac murmurs in 84. In reporting his observations Stanley gives the following graphic description of heart failure and of the heart symptoms in beriberi:

In both diphtheria and beriberi sudden heart failure is the most terrible complication, and one in which, as a rule, no treatment is available in preventing death. * * * In both these diseases the occurrence of vomiting is almost the invariable herald of a rapid, fatal termination by heart failure. Practically speaking, the main signs met with in heart failure occurring in any of these conditions are vomiting, restlessness, lilac-tinted pallor, dyspnœa, increasing weakness of the pulse, and coldness of the extremities. * * * The syncopal attack is marked rather by duration than by intensity; loss of consciousness is rare. * * * The usual time of death from heart failure appears to be about the end of the first week in diphtheria and toward the end of the first month in beriberi. * * * The heart signs of myocardial degeneration are lowered pulse tension, feeble, short pulse wave, feeble heart impulse, short first sound and relatively accentuated pulmonary second sound. The second sound is almost always reduplicated. Reduplication of the first is not unusual and is the cause of the cantering rhythm so frequently met with just before death. Some dilatation of the heart is frequent but not invariable. The cardiac impulse is usually feeble and, when there is dilatation, diffuse. Not rarely the heart's action is bounding and apparently forcible, but the actual circulatory output, as measured by the pulse, is remarkably feeble by comparison, there being a marked difference between the violent overaction of the heart and the small, feeble pulse. Some change in the heart rhythm is invariable; changes in the length of the pauses of the heart cycle being frequent and of great importance in prognosis. Most common is a shortening of the long pause, giving rise to spacing of the heart sounds. The relative shortening of the long pause may be of all degrees up to tic-tac rhythm, where the short equals the long pause, so that the heart sounds are equidistant. The change in the relative length of the two heart pauses is almost always accompanied by a change in the character of the sounds, the first sound becoming like the second in quality, losing its deep, so-called muscular sound, and making more audible the valvular sound, which resembles the ordinary valvular second sound. In this way the two sounds and the two intervals tend to become alike. This tic-tac rhythm caused by the shortening of the long pause--the recuperative intervals indicates diminished cardiac recuperative power, and prognosticates danger ahead—danger of heart failure. But of worse prognosis is that condition where, in addition to the long pause being shortened, the short pause is likewise shortened, so that the second sound follows very closely on the first. This condition is almost always a fatal sign, and occurs with or may be followed by heart failure. A condition characterized by what may be termed delayed beats or "tumbling rhythm" is a common feature of irregularity of the heart's action, both in diphtheria and beriberi. After a series of regular heart beats, a pause occurs, followed by a sudden scramble of two or more heart beats in order, as it were, to make up for lost time. This gives rise to an intermittent pulse, because all the beats do not reach the pulse.

When the disease ends in recovery, the disturbances of circulation decrease in intensity. In the wet form a profuse secretion of urine occurs and the œdema gradually disappears. In both types which progress favorably, the disturbances of sensation and the paralysis gradually disappear and the patient regains the use of his limbs.

INFANTILE BERIBERI.

Hirota[42] first called attention to beriberi occurring among infants suckled by mothers suffering from *kakke*. He gives a summary of 52 cases which he observed and enumerates the following as the most important symptoms of the condition:

The heart's action is accelerated; the second pulmonic sound accentuated; heart's area of dullness generally increased toward the right side; sound at the apex sometimes dull: pulse rapid, soft, having the character of *pulsus celer;* diastolic arterial sound sometimes heard over the crural artery, dyspnœa and aphonia almost without exception present; vomiting, cyanosis, and œdema occur very frequently; urine generally diminished; indican test sometimes positive, no albumen; general condition characterized by depression, constant crying and groaning; sensorium, clear; no fever. The sensory and motor disturbances of the patients could not be tested on account of their age.

Hirota first medicinally treated a number of cases of this type of beriberi in children, who had been suckled by mothers sick with *kakke*, but without success. However, he soon found that such patients rapidly improved when taken away from their mothers and either given to a healthy wet nurse or fed on artificial food. He therefore recommended this procedure as the only rational therapy. However, it was successful only when the disease had not progressed too far.

The author has made inquiries among a number of practitioners in Manila to ascertain whether beriberi in infants occurs in the Philippine Islands under the same circumstances under which Hirota has observed it in Japan. He has been repeatedly assured, for instance by Dr. Albert, that such cases are not very infrequent. However, the suggested proper therapy—i. e., of taking the child away from a mother (who frequently only shows mild symptoms of beriberi)—is very difficult to carry out in practice, since the people do not understand the necessity for such a measure.

COMPLICATIONS AND SEQUELÆ.

The most common complications of beriberi are tuberculosis and dysentery, and in some localities, malaria. When these conditions coexist the prognosis is usually very grave. Whereas most cases of beriberi end in rapid recovery, some assume a protracted course and in the latter, general weakness with or without anæmia, difficulty in the use of the lower extremities, contraction and induration of the muscles of the calf, and also disturbances of motility in the upper extremities, diminution and disturbance in the quality of the sensation, palpitation of the heart, and rapid pulse may remain present for a long time. As a rule, these symptoms all disappear under proper treatment and diet. It has been

[42] Hirota: Ueber die durch die Milch der Kakke (Beriberi) leidended Frauen Verursachte Krankheit der Säuglinge. *Centralbl. f. Innere Medizin* (1898), **19**, 385; also *Zeitschr. d. Mediz. Ges. zu Tokyo* (1891), **5**.

noticed in Europeans or Americans who have suffered from severe attacks of beriberi and who have returned to their native country during convalescence, that the disease frequently assumes a protracted course, from which recovery is very slow.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS.

In many cases of beriberi occurring among the uneducated and ignorant Asiatics, the diagnosis must be made exclusively from the objective symptoms, as an intelligible history is unobtainable. The most important points to be emphasized are the following: The condition of the pulse while the patient is at rest and before he has been at all disturbed; and the same after the patient has been subjected to some physical exertion. If the patient is not too ill, he should be compelled to leave his bed and to walk up and down the room a few times. While so doing, the gait should be noted, in order to ascertain whether it presents the characteristic appearance. The pulse should then once more be counted because it is usually very excitable in beriberi, and its rapidity increases very markedly even on very slight exertion. The percussion and auscultation of the heart are also of special value in the diagnosis of this disease. Particular importance attaches to the enlargement of the right ventricle, to the accentuation of the second pulmonic sound, and to a reduplication of the second mitral one. The presence of hydropericardium, hydrothorax, and abdominal ascites is of considerable value in the diagnosis; the increase of the patellar reflex in the early stages of the disease and the loss of it in the more advanced ones is also important. The frequency of pain in the muscles of the calf and of œdema in the legs and feet has already been referred to in the consideration of the symptomatology. The great decrease or even the suppression of the urine in the early stages of the œdematous form of the affection is also a very important factor in the diagnosis; the disturbances of sensation and of locomotion and the paralysis and contractions have been sufficiently emphasized under the symptomatology. Scheube thinks that the diagnosis of beriberi in a majority of the cases offers no particular difficulty, and that the most important symptoms to be looked for are hypæsthesia in circumscribed places (particularly of the legs and feet), œdema of the legs and of the dorsum of the feet; pain on pressure in the muscles of the calf; absence or increase of the patellar reflexes, palpitation of heart, accelerated, easily excitable pulse, and increase of the number of pulse beats after slight exertion.

Baelz and Miura [43] particularly mention the following among the diseases and their symptoms which might be confounded with beriberi:

Spinal myelitis: Increased reflexes; ankle clonus; paralysis of the extremities without muscular atrophy; paralysis of the bladder and rectum; complete

[43] Baelz and Miura: Beriberi oder Kakke. Mense, *Handb. d. Tropenkrankheiten*, Leipzig (1905), 2, 140.

anæsthesia, without pain in the muscles of the calf; no electric degeneration reaction; no symptoms on the part of the heart and kidneys. In *Landry's paralysis* there is fever at the onset, and pain in the head, with much perspiration at the back and extremities. A study of the sensation and circulation reveals nothing abnormal. *Tabes* usually should not be confounded with beriberi or vice versa. In anæsthetic leprosy a thickening of the peripheral nerves and *true anæsthesia* is found and *not hypæsthesia* which is generally encountered in beriberi. In addition, in leprosy spots or nodules or diffuse thickenings of the skin are usually encountered. Obviously, a careful search will reveal the presence of the leprosy bacillus.

Certain cases of *peripheral nephritis,* depending upon chronic alcohol or arsenic intoxication, may at times be exceedingly difficult to differentiate from beriberi. Alcoholic neuritis should first be definitely excluded before a diagnosis of beriberi is made in Europeans and Americans living in tropical countries, where beriberi is prevalent, and who present symptoms suggesting the possibility of an attack of this disease. In Japan and the Philippine Islands, where beriberi is so frequent and so well known, patients often consult the physician with the simple statement that they are suffering with this disease. But, of course, such a statement can not be accepted without verifying its correctness by a proper examination.

PROGNOSIS.

The prognosis of beriberi varies greatly in different epidemics and in different localities. The disease is generally most fatal, like other infections, when it first invades an entirely new territory in which it has not before been prevalent, or at least not been present for several generations. Scheube emphasizes the great uncertainty of the prognosis in beriberi because, even in apparently very mild cases, a profound cardiac disturbance may suddenly supervene. If this condition appears, then the prognosis always becomes grave. On the other hand paralyses *per se* are not indicative of a fatal issue. The mortality in beriberi also varies very much in different epidemics, localities, and races. Among the Chinese prisoners at Shanghai, according to Stanley, the mortality is 20 per cent, but it has been 50 per cent among the Chinese patients of the Hongkong Government hospitals during the last ten years.[44] The death rate in cases developing in Bilibid Prison at Manila is likewise quite high. However, in these instances the conditions are somewhat exceptional and particularly unfavorable. With better surroundings the mortality from beriberi is usually low. Among the troops in Dutch India the death rate in this disease is given as between 2 and 6 per cent; with the English East Indian troops the figures are somewhat higher. According to Scheube the average mortality in Japan is 3.5 per cent. During the first year (1904) of the late Russo-Japanese war, there were

[44] According to a personal communication from Dr. M. V. Koch, physician in charge of the Government Civil Hospital for Infectious Diseases, Hongkong.

sent from the front to the military reserve hospitals of Hiroshima, Tokyo, etc., 50,340 Japanese soldiers sick with beriberi. Of these 1,024, or less than 2 per cent, died. During the same period of time, among the troops in Japan there developed 3,337 cases, of which only 44 died. So on the whole, taking a very large material as a basis, the prognosis *quoad vitam* is quite favorable in beriberi. However, nothing definite can be stated in an individual case of beriberi, because a fatal termination in consequence of heart failure may occur at almost any time during the course of the disease. Unfavorable symptoms are: marked dilatation of heart, great weakness and irregularity of the pulse and other grave disturbances of circulation, circumscribed œdemas on the trunk of the body, œdema of the lungs, and particularly, persistent vomiting. The last symptom is almost invariably the precursor of a rapid fatal termination, in consequence of heart failure. The mortality in the acute, pernicious form is always very high; in the subacute or chronic, œdematous type it is lower than in the former, but higher than in the dry, atrophic variety. A favorable prognostic omen is the appearance of a copious renal secretion after a partial or complete suppression of urine. Acute, pernicious cases, when fatal, always terminate by heart failure or asphyxia; in chronic cases death results from paralysis of the respiratory muscles, but occasionally from aspiration pneumonia or from general debility. The latter event is particularly liable to take place when tuberculosis or amœbic dysentery is present as a complication. The average duration of the cases of acute, pernicious beriberi is very short, while that of those of moderate intensity and of a moderately chronic character is perhaps between three and six weeks. Besides the above there are a large number of protracted cases, which extend over a period of months or even more than a year. These are characterized by muscular atrophies and joint fixations. However, generally even these cases, if properly treated and if placed under proper hygienic conditions and given proper nutrition, finally completely recover.

It has frequently been noticed in Japan, the Malay Peninsula, and the Philippine Islands that if a patient who has had one attack of this disease, and has completely recovered, is exposed to the same conditions which brought on the first one, he suffers a second or even a third attack. In this respect beriberi may perhaps be likened to pneumonia and some of the other infectious diseases, which, in certain individuals after the first attack, leave a predisposition to subsequent ones.

PROPHYLAXIS.

Our ideas on prophylaxis, in relation to beriberi, are still in a decidedly unsatisfactory state. The observance of the ordinary rules of hygiene and sanitation has frequently shown a favorable influence in restricting the spread of the disease. However, in other instances, beriberi will prevail in certain localities and under certain conditions, in spite of all

hygienic and sanitary measures. The late Russo-Japanese war furnishes a confirmatory example of this statement. The hygienic measures adopted in the Japanese army proved sufficient to limit to a minimum such diseases as typhoid, typhus, dysenteries, scorbutus, etc., but they were of no avail against beriberi. Beyond all doubt there is one factor which favors the occurrence and spread of beriberi in those countries and among those races where it is at all prevalent, and that is the crowding together of large numbers of persons into limited spaces, as in prisons, barracks, schools, factories, mines, and ships. If beriberi appears under such environment, the situations should, if possible, be abandoned as dwellings, or at least the number of inmates should be decreased and a thorough disinfection, airing, and drying should be undertaken. The statements in regard to the effects of a change from a rice diet to some other, as a prophylactic against beriberi, are up to the present time so hopelessly contradictory that reliable conclusions can not be drawn from them. Women sick with beriberi should not nurse children. Scheube recommends as prophylactic measures, draining of the soil, a rational sewer system, proper hygiene as to the supply of drinking water, ventilation of houses, removal of beriberi patients, examination of ships before departure and detention of persons afflicted with beriberi or suspected of having the disease.

TREATMENT.

There is no specific treatment for beriberi. A patient suffering from this disease should be confined to bed. Even in mild cases in the early stages of the disease, rest should be insisted upon, since it is important to reduce the heart's action as much as possible, in order to guard against future and often unexpectedly grave cardiac complications. It has generally been found very advantageous to administer the saline laxatives in large doses during the first stages of beriberi. A favorite Japanese prescription, used very extensively, is the following:

℞

Magnesii sulfurici	30 to 50 grams.
Acidi muriatici diluti	1.5 to 2 c. c.
Tincturæ amaræ	4 c. c
Aq. dest. q. s. ad.	200 c. c.

M. D. S. 30 c. c. three times per day.

This treatment should be continued during five to seven days, followed by an intermission of a few days, after which it should be repeated. Other laxatives and purgatives recommended are cream of tartar, infusion of senna, Carlsbad salt, castor oil, and aloes and jalap pills. Where there is marked œdema, Baelz and K. Miura recommend potassium acetate, potassium nitrate, or diuretin. Scheube has strongly advocated the use of digitalis in beriberi, but most other observers consider it of very doubtful value, and it has repeatedly been stated that in many cases it has a decidedly injurious effect in that it helps to produce

vomiting, great anorexia, and nausea. In severe, acute cases with great weakness of the heart, Baelz frequently observed good effects from large doses of cocaine given internally in amounts of from 0.05 to 0.15 or 0.20 grams per day. In acute or subacute cases, with signs of dilatation of the right side of the heart, while the pulse is still good, encouraging results have been obtained by withdrawing several hundred cubic centimeters of blood from the median cephalic vein. However, when the pulse has become weak, this procedure is dangerous, because of the possibility of sudden heart failure. In the presence of dilatation, venous congestion and a pulse which is already weakened, the withdrawal of blood by the aid of cups or leeches, applied over the precordial region, is often followed by a speedy amelioration of the symptoms of circulatory disturbance and of the difficulty of respiration. The author has seen a considerable number of Japanese soldiers sick with beriberi who were greatly benefited by this method of bloodletting. However, the improvement is frequently only temperary and a repetition of the procedure may or may not bring about good results, or the unfavorable symptoms may increase in severity in spite of a temporary amelioration.

Where there is a very marked hyperæsthesia (which, however, is rare in beriberi), bromide of potassium or morphia internally or chloroform externally are recommended. Vomiting and dyspnœa are frequently greatly ameliorated by the hypodermic administration of small doses of morphia.

It is very important that the muscular atrophies and contractions, so common in beriberi, should receive early and proper treatment. However, it is not advisable to begin the latter as long as there is marked œdema of the affected extremities. When the œdema has subsided, massage and passive movement are to be systematically practiced several times a day. As soon as the patient is able to do so, and when there is no longer any immediate danger of cardiac failure, moderate, active exercise should cautiously be begun. Should such exercise lead to a very marked increase in the pulse rate, it should be postponed. The atrophic muscles are to receive electrical treatment. When they still react to the Faradic current, the latter is to be used. Where there is complete degeneration reaction, the galvanic one should be employed, with the cathode situated peripherally over the nerve and the anode centrally applied. In the use of the Faradic current, Scheube recommends large sponge or roller electrodes, to be employed in a massaging manner. When there is paralysis of the phrenic nerve, M. Miura advises faradization, one sponge electrode being placed over the epigastric region and the other above and inside of the sterno-clavicular articulation, or the two electrodes may both be placed on the sides of the neck.

The diet in beriberi should be light and nutritious and should include a considerable quantity of milk. Both in Japan and in Java beriberi patients frequently receive the *adzucki-bean* (*Phaseolus mungo* var.

radiatus Bak.) as a part of their daily nourishment, and it is believed that this has both a favorable prophylactic and a curative tendency. In the Philippines, similar virtues are claimed for the *mongo* or *mungo-bean* (*Phaseolus mungo* L.). Rice should, in private practice at least, be entirely withdrawn from the daily diet of the patient. Alcohol in any form is considered inadmissible in the treatment of beriberi and it should be entirely withheld. A person sick with a severe type of beriberi, accompanied by grave circulatory disturbances, should not under ordinary conditions be removed to a distance. Even during the early stages of recovery, a long railroad journey may bring on a relapse with severe and dangerous heart symptoms. Cases which are mild from the onset and serious ones after complete recovery, may with advantage be removed from a beriberi-infected neighborhood to a high and dry locality free from this disease, and a change of climate and return to a more bracing atmosphere should be recommended to Europeans and Americans who have suffered an attack.

CONCLUSION.

(1) Beriberi, kakke, or *neuritis multiplex endemica* is an acute, subacute, or chronic disease, generally only prevalent in certain well-defined territories. It is clinically characterized by disturbances of circulation, of motion, and of sensation.

(2) Its most pronounced anatomical lesions are, first, hypertrophy and degeneration of the myocardium and degeneration of the peripheral nerves and skeletal muscles, and second, localized or more or less general œdema, parenchymatous degeneration of the kidneys, liver, and interstitial hepatitis.

(3) Beriberi is neither primarily a nutritional disturbance nor a simple intoxication like lead, alcohol, arsenic, or similar intoxications accompanied with multiple peripheral neuritis, but is an infectious disease.

(4) Our animal experiments and blood examinations appear to indicate very strongly that none of the claims brought forward for the discovery of a specific micro-organism for the disease can be looked upon as substantiated.

(5) While, in the absence of any positive evidence or proof, it is perhaps dangerous to venture on an hypothesis, I would like to express the belief that beriberi is due to an organism which gains entrance into the human body, either directly or through food, and there produces a toxin which in character and effect is similar to the diphtheria or tetanus toxin and which by an accumulative action gives rise to the well-characterized anatomical and histological lesions of beriberi.

ILLUSTRATIONS.[45]

PLATE I. Japanese soldier in the Hiroshima Kakke Hospital. Dry, atrophic beriberi with advanced muscular atrophies, contractions, and *pes equinovarus.*

II. Japanese soldier in the Hiroshima Kakke Hospital. Dry, atrophic beriberi. Paresis of the extensor muscles of the arms.

III. Native Filipino, prisoner in Bilibid Prison, Hospital B. Chronic, wet beriberi. Œdema of the legs and of the dorsum of the feet.

IV. Three native Filipinos, prisoners in Bilibid Prison and patients in the Main Prison Hospital. Chronic, wet beriberi. Œdema of the legs and of the dorsum of the feet.

V. Native Filipino, Constabulary private. Acute, wet beriberi. Great œdema of the legs and feet.

VI. Fig. 1. Acute, pernicious beriberi (Necropsy No. 1547). Longitudinal section of the popliteal nerve; Weigert-Pal stain. Showing degeneration of the myelin sheath. Low magnification.

Fig. 2. Acute, pernicious beriberi (Necropsy No. 1547). Longitudinal section of popliteal nerve; Weigert Pal stain. Showing rosary formation and honeycombing of myelin sheath. Medium magnification.

VII. Fig. 1. Acute, pernicious beriberi (Necropsy No. 1547). Longitudinal section of popliteal nerve; Weigert-Pal stain. Showing various types of degeneration of the myelin sheath. Medium magnification.

Fig. 2. Acute, pernicious beriberi (Necropsy No. 1547). Transverse section of popliteal nerve; Weigert-Pal stain. Showing varying degrees of degeneration of the myelin sheath. Medium magnification.

VIII. Fig 1. Subacute beriberi (Necropsy No. 1630). Longitudinal section of popliteal nerve; Weigert-Pal stain. Showing profound degeneration of the myelin sheath. Medium magnification.

Fig. 2. Subacute, wet beriberi (Necropsy No. 913). Longitudinal section of popliteal nerve. Hæmatoxylin eosin stain. Showing proliferation of neurolemma nuclei. Medium magnification.

IX. Acute, wet beriberi (Necropsy No. 1225). Section of myocardium. Hæmatoxylin-eosin stain. Showing fragmentation and segmentation. Medium magnification.

X. Fig. 1. Subacute, wet beriberi (Necropsy No. 913). Section of the myocardium. Hæmatoxylin-eosin stain. Showing loss of striation vacuolation, and granular degeneration. Medium magnification.

Fig. 2. Acute, pernicious beriberi (Necropsy No. 1595). Section of the liver. Hæmatoxylin-eosin stain. Showing fatty degeneration and necrosis in the central area of the liver lobule. Medium magnification.

[45] The photographs of beriberi patients are from the author's original plates, taken in Hiroshima, Japan, and in Manila, P. I. The microphotographs are by Charles Martin, photographer of this Bureau, from sections prepared and stained by F. H. Willyoung, of the Biological Laboratory, Bureau of Science.

XI. Fig. 1. Subacute, wet beriberi (Necropsy No. 913). Section of liver. Hæmatoxylin-eosin stain. Showing fatty degeneration and necrosis in the central area of the liver lobule. Medium magnification.

Fig. 2. Subacute, wet beriberi (Necropsy No. 1536). Section of the liver. Hæmatoxylin-eosin stain. Showing interlobular, periportal inflammatory focus. Medium magnification.

XII. Fig. 1. Acute, pernicious beriberi (Necropsy No. 1547). Section of stomach. Methylene blue-eosin stain. Profound eosinophilia of mucosa. Oil immersion.

Fig. 2. Acute, pernicious beriberi (Necropsy No. 1547). Section of duodenum. Methylene blue-eosin stain. Profound eosinophilia of mucosa. Oil immersion.

PLATE I.

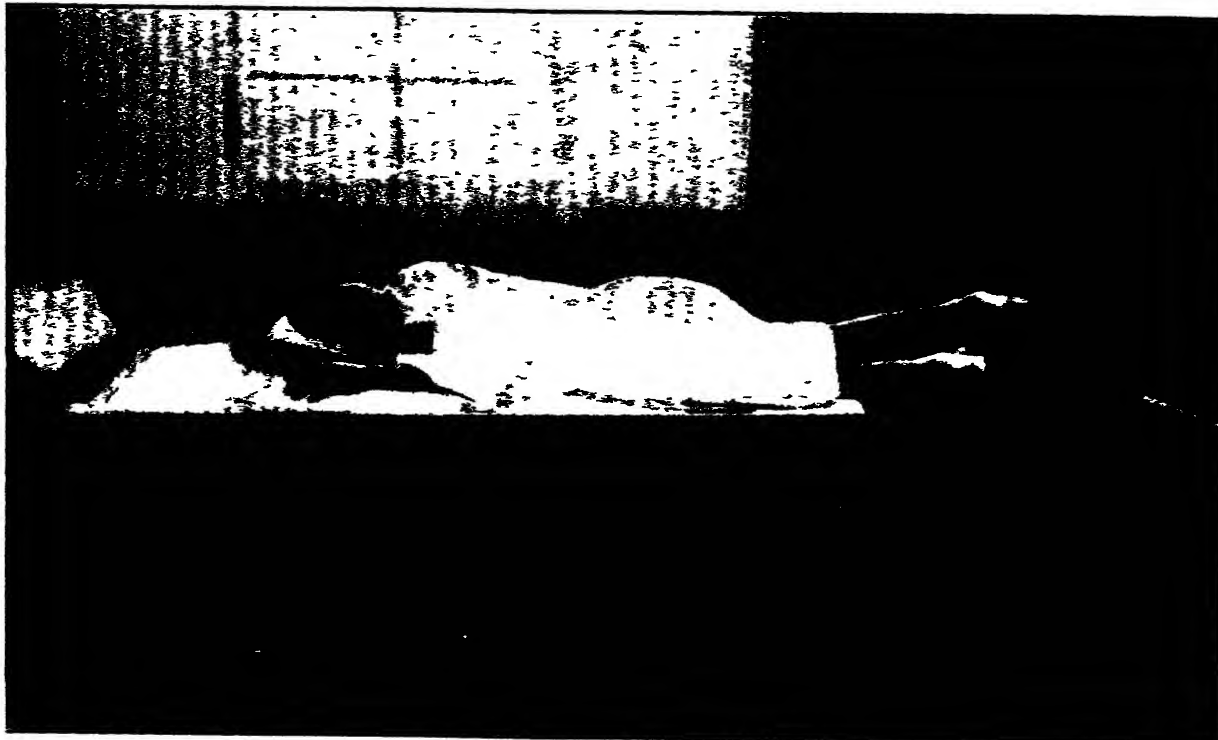


PLATE II.

PLATE III

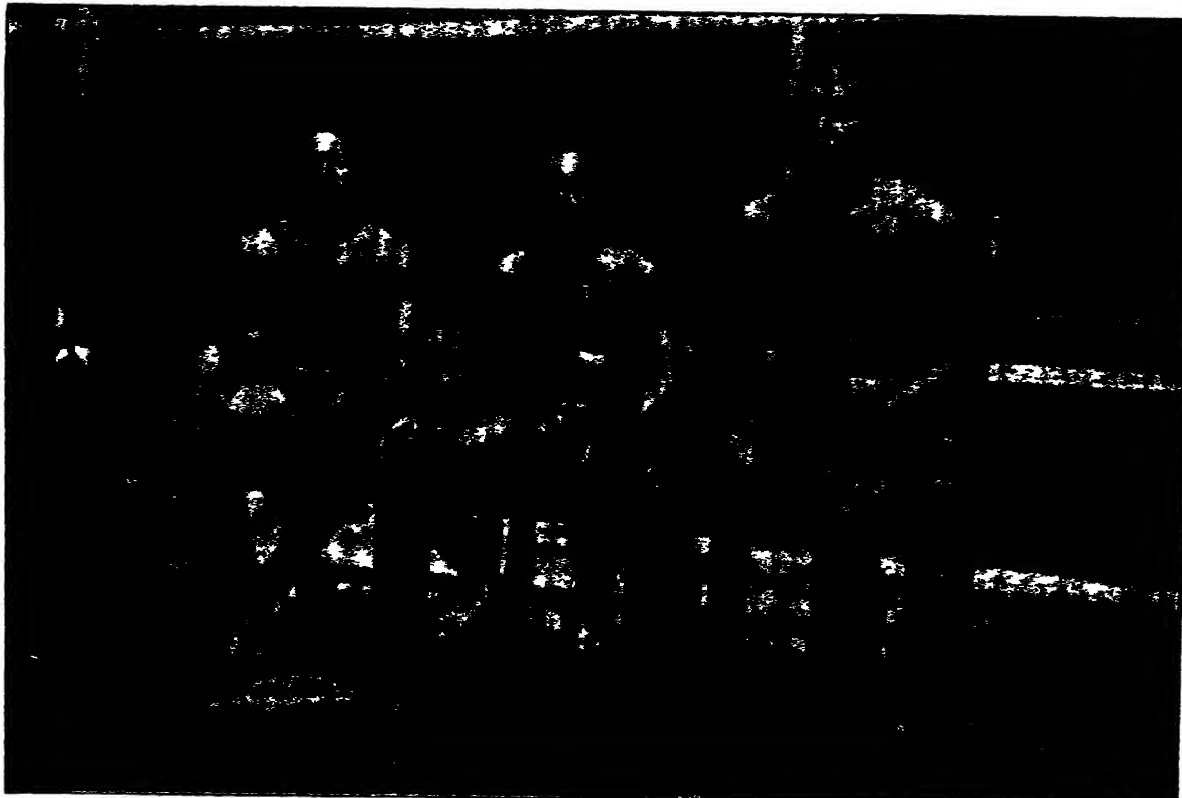


PLATE V.

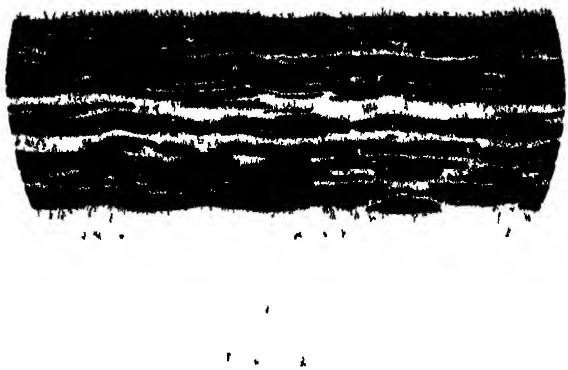


Fig. 1.

Fig. 2.

PLATE VI.

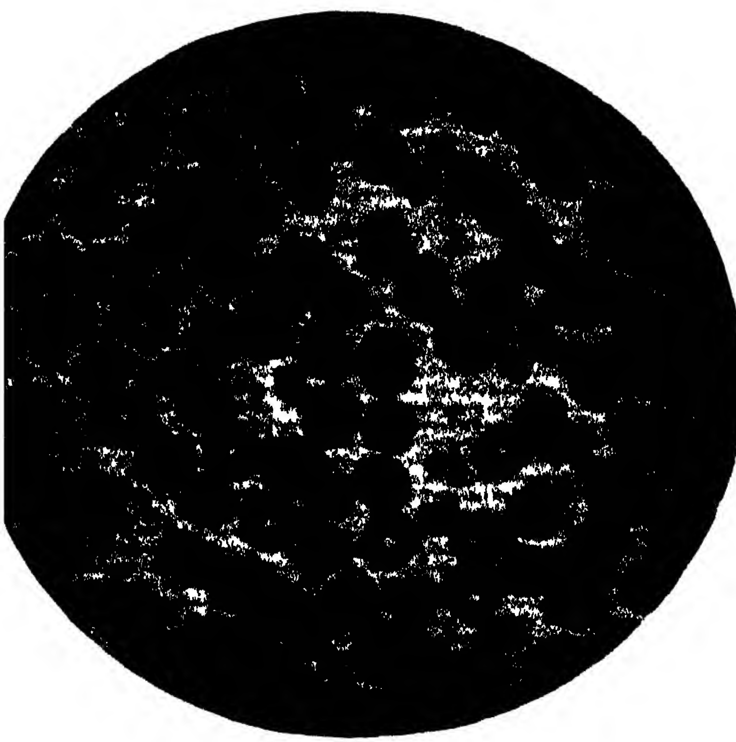


FIG. 2.

PLATE VII.

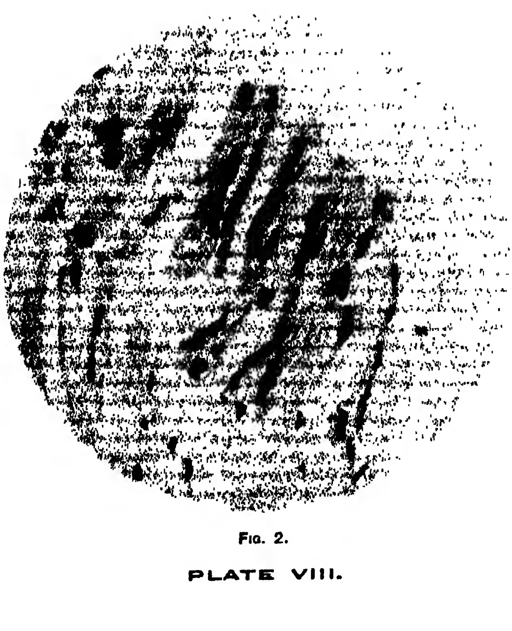


FIG. 2.

PLATE VIII.

PLATE IX.

Fig. 1

Fig. 2

PLATE X.

FIG. 1.

FIG. 2.

PLATE XI.

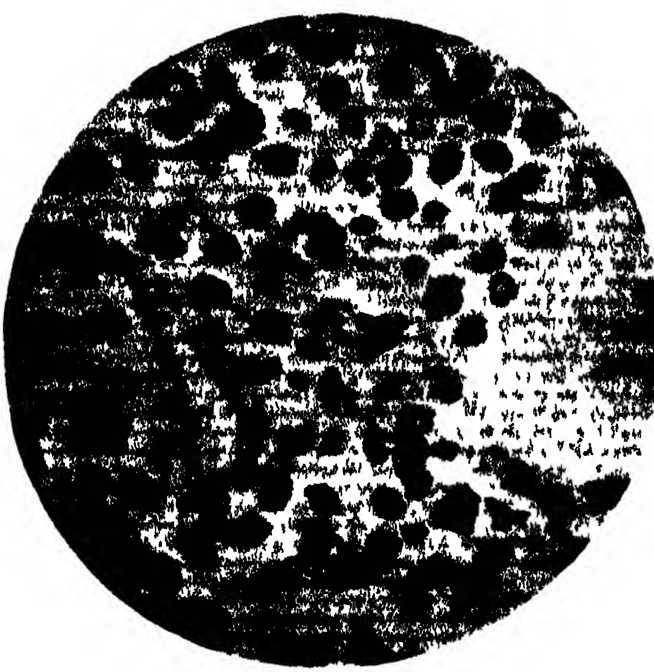


Fig 2

PLATE XII.

NOTES ON FOUR BIRDS FROM LUZON AND ON A SPECIES OF DOUBTFUL OCCURRENCE IN THE PHILIPPINES.

By RICHARD C. MCGREGOR.
(*From the zoological section of the Biological Laboratory of the Bureau of Science, Manila, P. I.*)

Strix candida Tick.

Two adult females and a full grown young barn owl were purchased in Manila February 15, 1906. They were said to have been taken at Biñang, La Laguna Province, Luzon.

The young bird, doubtless captured on the nest, is heavily covered with light, ochreous down; face brown; feathers of ruff white with blackish brown tips; rectrices and remiges partly developed. This specimen is of interest as it establishes the fact that the barn owl breeds in the Philippines. The eggs must have been deposited early in January.

Antigone sharpei Blanf.

Mr. Worcester, in a letter dated April 25, 1906, has sent me the following interesting notes concerning the habits of the above species in northern Luzon:

It may interest you to know that I saw *Antigone sharpei* in large numbers in Cagayan and Isabela during my recent trip through those provinces. I am informed that these birds nest on the ground in May, contenting themselves with scraping together and flattening down a little grass on which to deposit their eggs. About August they lose their long wing feathers and when in this condition can rise but a few feet from the ground. The people of Isabela then pursue them on horseback and take them with lassoes, although according to the statements of the hunters the birds, aided by their wings, run about as fast as deer.

Herodias timoriensis Less.

While examining some mounted birds at the shop of a Filipino taxidermist I saw a white heron which belonged to the above species. It was still fresh, having been killed the previous week. I noted the following data:

Killed on the Laguna de Bay, Luzon, March 16, 1906. Sexed by the taxidermist as a male. Entire legs and feet black; bill yellow. Dorsal plumes reaching little beyond base of tail, the bird being in rather poor plumage. Tarsus, 6.25 inches; bill from gape, 5.5; culmen from frontal feathers, 4.5.

This species has not previously been recorded from Luzon, but a specimen was obtained in Mindanao by Mearns and recorded in Proceedings of the Biological Society of Washington (1905) **18**, 89.

Platalea minor Temm. and Schl.?

I am creditably informed of the recent occurrence of a spoon-billed ibis in Luzon, although I have been unable to examine a specimen myself. A Filipino taxidermist tells me that he saw specimens which were obtained in January, 1905, not far from Manila.

The plumage was white; the chin, lores, and a restricted area about the eyes were unfeathered; the legs and feet were dark brown. Some six birds were killed at one shot, but, unfortunately, they were eaten and neither skins nor any other parts were preserved. As this taxidermist is familiar with Philippine birds, I feel sure that his statements are reliable.

The spoon-billed ibis has been reported from Luzon, but we have no certain evidence as to which species occurs, and none of the recent collectors have seen it. We should be very grateful to anyone sending a specimen or even parts of this bird to this Bureau, with particulars relating to the date and place of capture. For the use of those likely to encounter the species, I subjoin a short compiled description of *Platalea minor:*

Plumage entirely white with a small crest; forehead, chin, side of face, and area about eye unfeathered; bill, slate color, transversely barred with black; inside of mouth black; bare skin of face black with a bright-yellow ochre patch before the eye; iris blood-red; legs purplish black. Length from tip of bill to tip of tail, 27 inches; bill, 7.2; last joint of wing, 14.6; tail, 4.2; tarsus (i. e., from base of toes to next joint of leg), 4.75. The spoon-bill is easily distinguished by the shape of its bill, which is spatulate. The spoon-billed, or more properly the shoveler, duck has a similarly shaped bill but in other respects bears no resemblance to the spoon-billed ibis.

Chaetura sp.?

I have received the following note from Mr. Worcester relative to the occurrence in northern Luzon of a giant swift:

On the evening of March 25, just below the Tinguiane settlement of Dipadi on the Ablug River, in the region commonly known as Apayao, I saw a flock of giant swifts of the genus *Chaetura*, numbering some forty individuals. Nearly all of them were flying in pairs, there being apparently only two or three old bachelors in the flock. The individuals of the several pairs did not seem to be pursuing each other but were apparently flying together for the sake of sociability. They were flying very low, occasionally skimming along the surface of the river and dipping into the water as they flew. Several individuals passed within twenty or thirty feet of me. It was most aggravating to be obliged to lose this very exceptional opportunity for collecting giant swifts, but as I had no shotgun with me I had to content myself with observing them as carefully as possible. I looked in vain for the white spot in front of the eye, which is so characteristic a marking of *Chaetura dubia*, recently discovered by you in Mindoro. However, the flight of these birds was so extremely swift that this marking may have been overlooked. All the individuals which were seen showed white markings on the under tail coverts and flanks. There was no light marking on the rump.

NOTES ON BIRDS FROM APO ISLAND.

By RICHARD C. MCGREGOR.

Mr. Worcester, on November 26, 1905, accompanied by two Filipino collectors from the Bureau of Science, made a landing on Apo, a small coral island 24 miles west from Sablayan, the point nearest thereto on the Mindoro coast.

Specimens of five species of birds were secured; with the exception of *Endynamis mindanensis* these are all migratory species and none of them gives us any clue to the zoölogical relationship of Apo.

Endynamis mindanensis (Linn.).

A male of the Philippine koel.

Turdus obscurus Gmel.

An adult male of this thrush. Mr. Worcester writes to me that "there was a great flock of the thrushes, of which we secured a single good specimen on Apo Island. They were evidently migrating and had stopped in this place to rest."

Acanthopneuste borealis (Blas.).

One specimen of the northern willow warbler.

Horornis canturiens (Swinh.).

A male specimen of this grass warbler.

Anthus maculatus Hodgs.

A male of the spotted pipit.

NOTES ON A COLLECTION OF BIRDS FROM BANTON.

By RICHARD C. MCGREGOR.

Banton is a small island situated some 16 miles directly north of Tablas. It has an area of 11 square miles. It is of volcanic origin and seems to be surrounded on all sides by deep water. Its surface is quite broken, the highest hills reaching an altitude of about 900 feet. Practically all of its forest land has been more or less completely cleared. There are numerous coconut groves on the island, and there is also an abundance of low scrub with occasional large trees, more or less completely isolated.

As no ornithological collector had ever before visited Banton, Andres Celestino, an assistant collector of natural history specimens in the Bureau of Science, was sent to that island in July, 1905. He collected during the period between July 23 and August 12, obtaining specimens of twenty-one species of birds.

Of these, *Otus romblonis* may or may not be of significance. At present we have too little knowledge of the distribution of this species to draw any conclusions from this occurrence. *Ceyx bournsi,* while unknown from the islands north of Banton, is so widely distributed that its presence there is of little importance. The presence of *Loriculus philippensis, Iole philippensis,* and *Zosterops meyeni* indicates a close relationship between Banton and the Luzon-Marinduque group.

LIST OF BIRDS FROM BANTON.

Streptopelia dussumieri (Temm.).

Two specimens of Dussumier's dove.

Chalcophaps indica (Linn.).

A female specimen of the Indian bronze-winged dove.

Otus romblonis McGregor.

Three small owls, two males and a female, from Banton Island do not differ from the type of the above species. The male has not been described but it is exactly like the female in coloration. Number 11040 in the Bureau of Science collection is hereby designated as the male type.

Measurements of Otus romblonis from Banton Island.

Number.	Sex.	Date	Wing.	Tail	Tarsus
11046	♂	Aug. 8	6.25	3.50	1.12
11047	♂	July 25	6.25	3.18	1.20
11048	♀	July 27	6.35	3.40	1.28

Loriculus philippensis (P. L. S. Müll.).

Four males from Banton July 23–28; two are in immature plumage, the others do not differ from specimens of *L. philippensis* from Luzon.

Ceyx bournsi Steere.

One specimen of Bourns's kingfisher appears to be typical.

Halcyon chloris (Bodd.).

One specimen.

Salangana troglodytes (Gray).

One specimen taken July 29.

Salangana marginata (Salvad.).

A small swift taken July 25 is undoubtedly of this species.

Hierococcyx fugax (Horsf.).

A female from Banton, July 28.

Centropus viridis (Scop.).

Several specimens.

Cyornis philippinensis Sharpe.

One specimen.

Hypothymis occipitalis (Vig.).

One specimen.

Rhipidura nigritorquis Vig.

One specimen.

Lalage niger (Forster).

A nest holding two large young was taken on Banton July 30. (Pl. II.)

This nest is an extremely slight structure with a very shallow cup, reminding one of a dove's nest. The material of which it is constructed consists of small plant stems and tendrils with which are mixed a few bits of bamboo leaves; there is no lining. The nest is 3 inches across the top and is but an inch deep by outside measurement.

The two young which were nearly ready to leave the nest, are slate-brown above, most of the feathers widely tipped with ochreous brown, those of the back with a darker, subterminal band. The wing and tail feathers are black, with wide white, or buffy-white, edges; lower parts white, spotted with black on the chin, throat, breast, sides, and under tail coverts, these spots largest on the forebreast.

Iole philippensis (Gm.).

Eleven fruit-thrushes from Banton, July 23 to August 12, are a trifle lighter in color than Luzon specimens, but the difference is very slight; in measurements they are much nearer *philippensis* than *guimarasensis*, as may be seen by an

examination of the accompanying table. The specimens from Banton are in very poor plumage, so that lengths of wing and tail are of little value but they are here given for the sake of completeness. The interesting fact is that the Banton bird is neither *cinereiceps* nor *mindorensis*, although either of these species might have been expected to occur in Banton, judging from its position.

Average measurements of Iole guimarasensis and Iole philippensis.

No. of skins.	Locality.	Wing.	Tail.	Exposed culmen.	Bill from nostril.	Tarsus.
10	Masbate and Ticao	4.20	3.55	0.92	0.67	0.82
10	Mariveles	3.94	3.55	.81	.61	.78
5	Banton	3.82	3.62	.85	.61	.76

Megalurus ruficeps Tweedd.

Three specimens.

Artamus leucorhynchus (Linn.).

A male and a female.

Zosterops meyeni Bp.

I can not distinguish specimens of the silver-eye of Banton from numerous specimens collected in Calayan, Lubang, Verde, and in Tarlac Province, Luzon. Specimens from Benguet Province, Luzon, seem to be more dusky and may more closely resemble *Zosterops whiteheadi* of Lepanto Province than *Z. meyeni* of Manila and vicinity. However, all of our Benguet specimens are more or less darkened from feeding in burned timber and none are in fine plumage.

Young birds of various sizes collected in Banton, July 24 to August 2, do not differ in color from the adult, except that the yellow throat patch is slightly lighter.

Two eggs taken July 25 are pale blue and unspotted; they measure in inches: 0.62 by 0.49 and 0.68 by 0.49. A nest taken July 29 and containing one egg is composed of fine, yellow, plant fibers without lining; inside depth, 1.5 inches; inside diameter, 2 inches. The egg is pale blue and unspotted; it measures 0.61 by 0.49 inch. (Pl. III.)

Munia jagori Martens.

One specimen.

Oriolus chinensis Linn.

Two females; one in badly worn plumage was taken July 30.

Sarcops calvus (Linn.).

Five specimens of the bald-headed starling from Banton; in a male (No. 10815 ♂) the chin and lores are light seal brown and two feathers on the throat are pure white. Another specimen (No. 10814 ♀) shows the same variation in color of lores and chin. Two others have a few brown feathers on the lores. No other specimens in our large series from other islands show similar variations.

NOTES ON A COLLECTION OF BIRDS FROM THE ISLAND OF TABLAS.

By Richard C. McGregor.

The birds of Tablas have heretofore been known only from the collection made on this island in 1892 by Mr. Worcester, aided by one native collector. Two of the new species discovered by Worcester in Romblon, namely, *Iole cinereiceps* and *Dicaeum intermedium*, were found by him to inhabit Tablas also, while two additional new species, *Rhipidura sauli* and *Chibia menagei*, were discovered, the latter being by far the most remarkable representative of its genus known to inhabit the Philippine Islands.

As Tablas is an island of some size and still has a considerable area of undisturbed forest remaining on the slopes of the high hills and low mountains in its interior, it was hoped that other new species might be discovered there, especially as Worcester was ill during the greater part of his stay on the island and was consequently unable to do any collecting himself.

Two assistant collectors from the Bureau of Science were accordingly sent to Tablas, but although they worked diligently from August 15 to September 30, 1905, they did not discover any new species.

They did secure a fairly good series of specimens belonging to all of the new species discovered by Worcester and increased those known to inhabit Tablas by four, namely, *Osmotreron axillaris*, *Gallicrex cinerea*, *Pernis ptilonorynchus*, and *Salangana marginata*.

LIST OF SPECIES COLLECTED.

Osmotreron axillaris (Bp.).

Three specimens.

Phapitreron nigrorum Sharpe.

Eleven specimens.

Leucotreron leclancheri (Bp.).

Six specimens.

Muscadivora aenea (Linn.).

The "balud" of Tablas probably belongs to the variety *calybura* which seems to be fairly distinct from true *ænea* of Borneo.

Streptopelia dussumieri (Temm.).

Two specimens of this common dove were taken in Tablas.

Gallicrex cinerea (Lath.).

Four eggs from Badajos, September 4, 1905. Measurements in inches: 1.53 by 1.11; 1.50 by 1.09; 1.58 by 1.12; 1.56 by 1.10. Surface smooth, with a light gloss; ground color, creamy-white. The few spots are of medium size, irregular in outline and are scattered over the entire surface; in color they are dull lavender and dull reddish-brown.

Lophotriorchis kieneri (Geoffr.) ?

A hawk from Badajos seems to be an immature male of the above species. The following notes sufficiently characterize the specimen:

> Lores and a wide stripe above eye black, separated from the cere by an extension of the white forehead patch, which also extends backward in a narrowing line above the black eye stripe; long crest feathers blackish, with light tips; rest of upper parts brown, nearly all the feathers with white or at least whitish tips, most pronounced on crown, and secondaries and their coverts; head and neck lightest brown, wings much darker; primaries and coverts, secondaries, and rectrices almost black, the last with conspicuous white tips and banded as in the adult, but more distinctly; quills also barred as in adult; entire lower parts pure white except a patch of light-brown feathers on each flank.[1]

Spilornis panayensis Steere.

A male was obtained on Tablas September 12.

Haliaëtus leucogaster (Gm.) ?

A specimen from Tablas is probably the young of this species but it does not agree very well with the descriptions. The identity of this specimen does not in any away affect the known distribution of the species, as the white-bellied eagle undoubtedly occurs in Tablas.

Pernis ptilonorhynchus (Temm.).

A female of the honey buzzard from Tablas, taken September 14, is extremely pale in coloration, the short, scale-like feathers of the lores being much lighter than in any of four other skins at hand. This great difference might lead one to suspect that they represent two species were it not for the known variation in this genus. Newton in his article on the honey buzzard in the Dictionary of Birds, page 427, says:

> "The species is still further remarkable for the great difference of coloration exhibited by individuals belonging to it, which have hitherto defied all attempts at reduction to what passes for "law"; but the widest variation is observable in young birds of the year, while the assumption of an ashy-grey head is held to indicate maturity."

Prioniturus discurus (Vieill.).

Five specimens.

Tanygnathus lucionensis (Linn.).

A male from Badajos.

[1] An adult male of *Lophotriorchis kieneri* taken in Sibuyan, June 13, 1904, was accidentally misnamed on the tag and therefore omitted from my paper on birds of Sibuyan in *Publications of the Bureau of Government Laboratories* (1904), 25.

Loriculus bournsi McGregor.

Among 24 specimens of this species from Tablas there are but 4 adult males and even these are not in perfect plumage. They show the characters assigned to this species.[2]

Eurystomus orientalis (Linn.).

A male of the oriental roller from Badajos, Tablas, August 22.

Ceyx bournsi Steere.

A pair of the Bourns's kingfisher.

Halcyon chloris (Bodd.).

Three specimens of the common green kingfisher.

Halcyon winchelli Sharpe.

Three specimens of Winchell's kingfisher.

I think the one described by Sharpe[3] was an immature bird. At any rate the adult male is pure white below, as illustrated by a specimen in the present collection from Tablas, August 31. The other two skins are marked female and are in moult, the lower parts fawn color as described.

Merops americanus P. L. S. Müller.

Three specimens from Badajos, September 12, 1905.

Salangana marginata (Salvad.).

One specimen from Badajos, September 6.

Cacomantis merulinus (Scop.).

One specimen in mixed plumage, September 13.

Eudynamis mindanensis (Linn.).

Two males and a female.

Centropus viridis (Scop.).

Six specimens.

Xantholaema roseum (Dumont).

Nine specimens of the rosy barbet were collected.

Pitta erythrogaster Temm.

One specimen.

Pitta atricapilla Less.

The black-headed ground-thrush appears to have been abundant in Tablas, as the collection contains ten specimens, in fine plumage.

Cyornis philippinensis Sharpe.

Two specimens.

Hypothymis occipitalis Vig.

One specimen.

Rhipidura nigritorquis Vig.

One specimen.

[2] McGregor: *Publications of the Bureau of Government Laboratories* (1904), 23, 16.

[3] *Cat. Bds.*, 17, 255.

Rhipidura sauli Bourns & Worcester. (Pl. V.)

Three specimens of Saul's fantailed flycatcher.

Zeocephus rufus (Gray).

Two pairs of the rufous flycatcher.

Artamides mindorensis Steere.

Four specimens.

Lalage niger (Forster).

One specimen.

Iole cinereiceps Bourns & Worcester.

Twenty-one specimens of this fine species from Badajos, August 15 to September 29.

Pycnonotus golavier (Scop.).

A male.

Copsychus mindanensis (Gm.).

An adult male from Badajos, September 4; two full-fledged young from the same locality, September 8. The adult male has bill and tail considerably longer than a male from Quisao, Luzon. The young differs from the adult as follows:

Head, neck, and back dull black; chin, throat, and forebreast dull black with a whitish spot on each feather; a few glossy, blue-black feathers of the adult plumage on breast, back, and rump.

A set of three eggs from Badajos, August 15, have the following characteristics:

Pale green, very heavily blotched with dark lavender and olive brown; spots crowded about the larger end and nearly covering the ground color. Measurements in inches. 0.92 by 0.70; 0.92 by 0.70; 0.94 by 0.70.

Megalurus ruficeps Tweed.

Three specimens.

Acanthopneuste borealis (Blas.).

One specimen from Badajos, September 13.

Artamus leucorhynchus (Linn.).

A female.

Otomela lucionensis (Linn.).

Four specimens of the Luzon shrike from Badajos. This and previous records of *O. lucionensis* made by me are not satisfactory, as many of the specimens are, without doubt, something else. Birds with the upper parts earthy brown and the frontal half of the head grayish white, may be referred with confidence to *O. lucionensis*. However, there are other specimens with no white frontal band and with the upper parts strongly cinnamon-brown or even rufous, these can not be named without comparison with well-determined material. Specimens from the following localities are believed to be true *O. lucionensis*:

Lamao, Bataan Province, and Manila, Luzon, Cuyo, Mindoro, Lubang, and Cagayancillo.

The majority of the Philippine shrikes of this genus have the under parts marked with dusky cross vermiculations, indeed it is very unusual to find an individual entirely free from these markings.

Hyloterpe winchelli Bourns & Worcester.

Twelve specimens of Winchell's thickhead.

Dicæum intermedium Bourns & Worcester.

An extensive series of this little flower pecker from Badajos. Bourns and Worcester[4] suggested the possibility that the Romblon bird might prove to be distinct from those of Tablas, but I find no points in which birds from the two islands differ; the heavier yellow wash on the throat of some of the Tablas specimens is probably due to immaturity. The young of *D. intermedium* does not differ from that of *D. sibuyanicum*, already described by me.[5]

Birds in immature plumage were taken from August 15 to September 19. The first indications of the adult plumage is a small patch of orange feathers on middle of breast. No. 10749 ♂, Bureau of Science collection, taken at Badajos, Tablas, September 5, 1905, is selected as the type of the young plumage.

Æthopyga magnifica Sharpe.

Six specimens.

Cinnyris sperata (Linn.).

An immature male, September 5.

Anthreptes chlorigaster Sharpe.

Twelve specimens taken at Badajos in August and September are in young or moulting plumage.

Anthus rufulus Vieill.

Two specimens from Tablas, August and September.

Munia jagori Martens.

One specimen.

Oriolus chinensis Linn.

A male.

Chibia menagei Bourns & Worcester. (Pl. IV.)

This very distinct species is represented by a number of skins taken in August and September. Unfortunately, the magnificent tail feathers are badly worn, this fact greatly injuring the appearance of the specimens.

Sarcops calvus (Linn.).

Ten specimens.

Lamprocorax panayensis (Scop.).

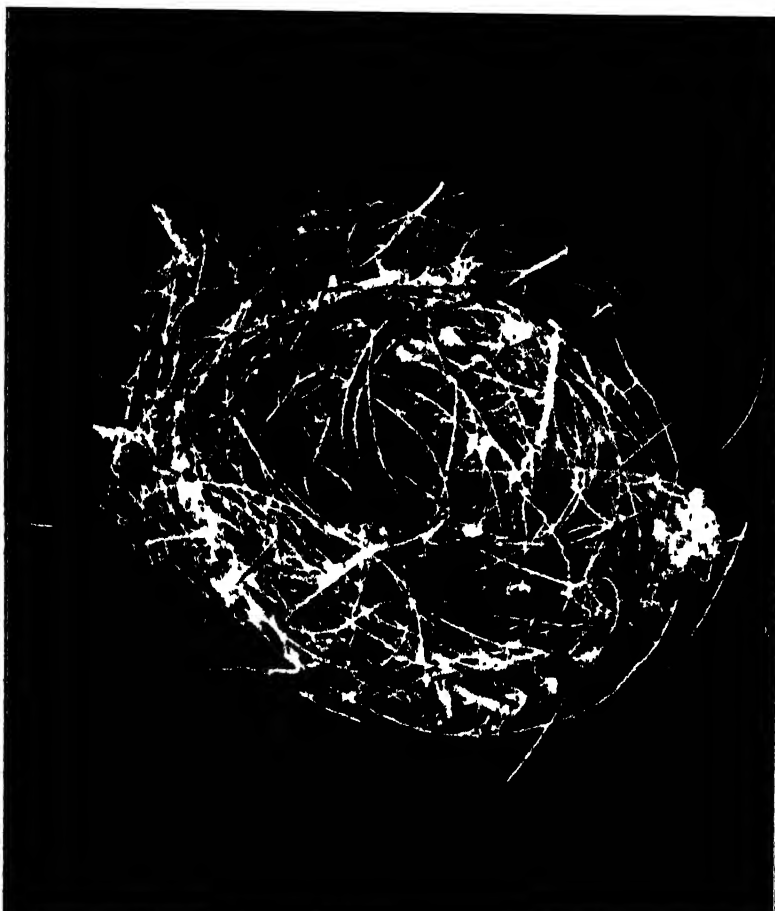
Three specimens of the Panay starling.

[4] *Occ. Pap. Minn. Ac.* 1, 18.

[5] *Publications of the Bureau of Government Laboratories*, 25, 18.

ILLUSTRATIONS.

PLATE I.



PLATE

PLATE III

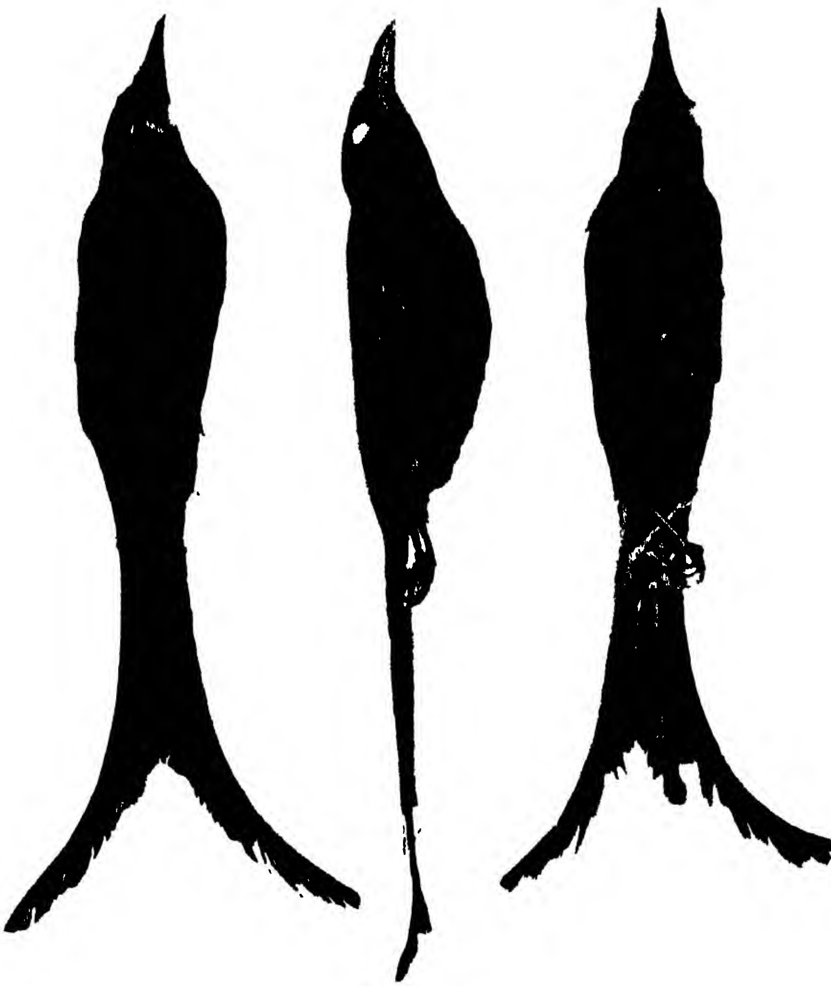


PLATE IV

PLATE V

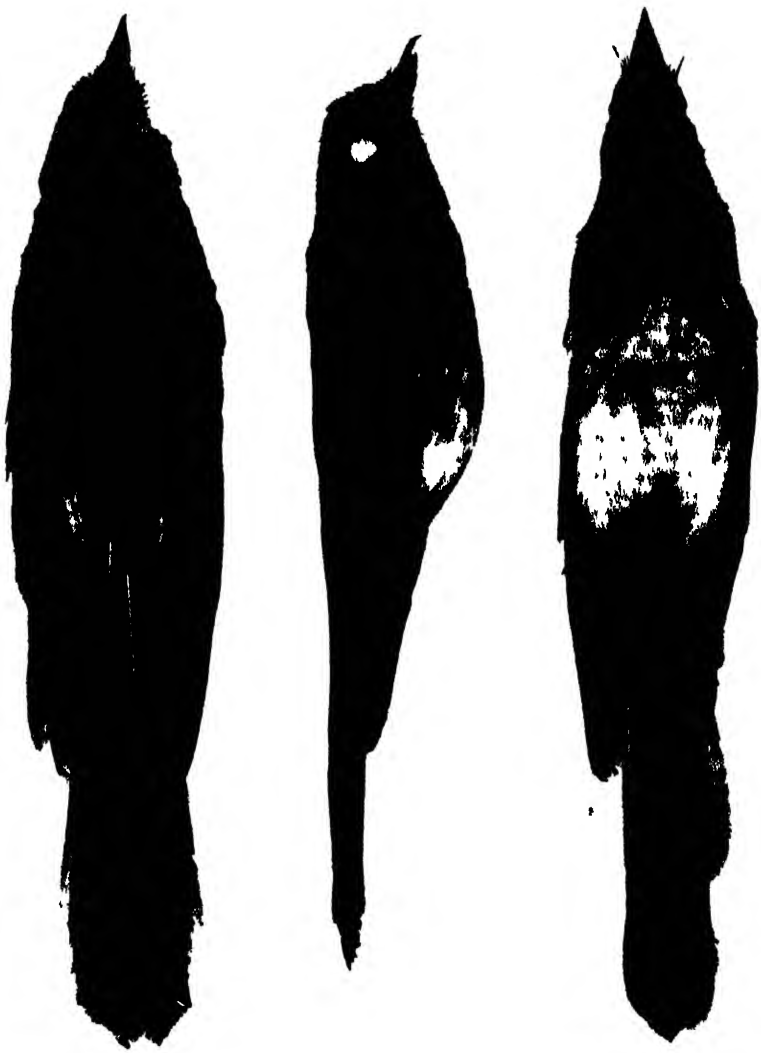


PLATE VI

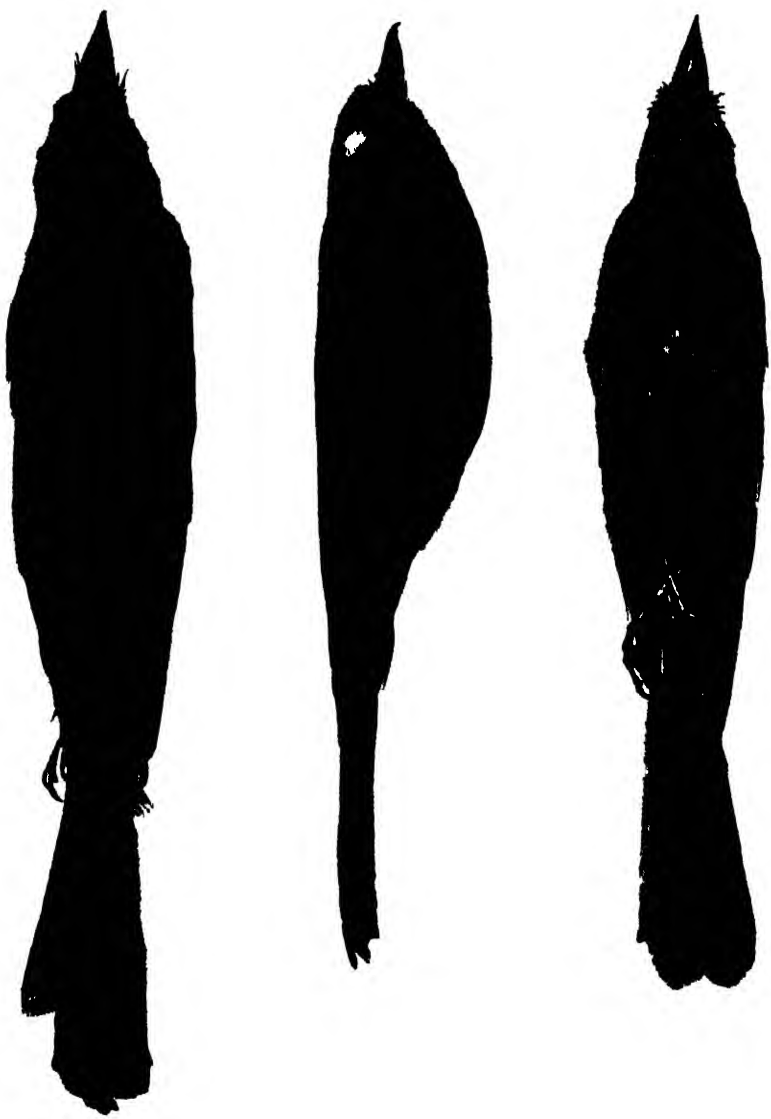


PLATE VII

A NEW GENUS AND SPECIES OF CULICIDÆ.

By CHARLES S. BANKS.
(*From the entomological section, Biological Laboratory, Bureau of Science.*)

Family CULICIDÆ.

Subfamily TOXORYNCHITINÆ.

Genus WORCESTERIA gen. nov.

Head with closely applied, wide, flat scales (Pl. I, fig. 1) and a very small group of upright, truncated, bastonate scales (Pl. I, fig. 2) having distal extremities crenulate, on extreme occiput, near nape; a tuft of six curved bristles projecting over eyes; thorax and abdomen with flat scales; legs and palpi with narrow flat scales. Palpi in the ♀ short, *5 jointed*, fourth and fifth almost microscopic, being, together, not as long as width of third joint, and less than ⅛ as wide as preceding joints (Pl. I, figs. 3 and 4); in the ♂ *3 jointed*, acuminate, reflexed before middle, first joint composed of three segments anchylosed and with but faint evidence of former segmentation expressed by arrangement of scales (Pl. I, figs. 5 and 6); proboscis long, tapering and curved as in *Toxorhynchites* and *Megarhinus;* distal segment bilabiate, prothoracic lobes strongly swollen, each bearing a laterally projecting, vertical row of curved spines; wing venation as in *Megarhinus*, the first submarginal cell ½ as long and ½ as wide as the second posterior, its proximal angle very acute, that of the second posterior being rather more rounded, the arrangement of the cross veins differs in the sexes, the supernumerary being farther removed from the mid cross vein in the ♂ than in the ♀ and the mid cross vein being also slightly shorter in the ♂; the cyclic vein[1] very prominent and two parted, equally pronounced in both sexes, its curve, the reverse of that in *Megarhinus* (Pl. I, fig. 7); metanotum longitudinally slightly sulcate on median line, densely pilose; abdomen bordered laterally with sparse hairs to fifth segment, then having dense lateral tufts of variegated hairs; legs of both sexes strongly spinose except last two tarsal segments; ungues of ♀ simple and equal; those of ♂ unequal, the larger unidentate on fore and mid legs, equal on hind legs and very small; male genitalia having the bulbous basal segment strongly setose, the distal segment long, very slender, double curved, the apical tooth being placed ventrally before the apex. (Pl. I, fig. 8.)

The type of the genus is *W. grata* sp. nov., described herewith.

I take great pleasure in dedicating this new genus in a most interesting group of insects, to Mr. Dean C. Worcester, to whose personal efforts,

[1] I have adopted this term as a name for the vein which curves upward and inward or is reflexed from the end of vein 5 into the anal cell in the *Megarhinina* and *Toxorhynchitinæ*.

both through study and assistance, scientific research is lastingly indebted in the Philippines.

While this genus possesses characteristics of both *Megarhinus* and *Toxorhynchites*, it is so entirely different from either of them in those characters upon which these two genera are erected that I have not the slightest hesitation in placing it as distinct.

So much incertitude has existed in the matter of palpal segmentation that it is most gratifying to have been able to breed and study a large series of individuals and by that means to have been able, by careful dissections, to found the genus upon certainties. I fear that inability to obtain large numbers of individuals in this as in other subfamilies, has been the source of no little confusion as to important features.

I personally do not approve of one-species genera and should have preferred studying species in the other genera of this subfamily before forming this one, but I am certain that when such study is made other species now supposed to belong to *Megarhinus* and *Toxorhynchites* will fall here.

Worcesteria grata gen. et sp. nov.

Length ♂ 12 millimeters, proboscis 7 millimeters, ♀ 10 millimeters, proboscis 7 millimeters, length of wing 8.25–8.75 millimeters; head, thorax and abdomen dark, metallic brownish-blue, the head and mesothorax being lighter blue laterally as are the prothoracic lobes and the dorsal ridge of the first abdominal segment. Legs variegated blue, wine-color and orange-yellow, the last color in the ♀ only, the leg bands being different in the sexes and containing much white in the ♀.

♀, head with flat, light-greenish variegated metallic scales, a few dark, crenulately truncated, bastonate scales on extreme occiput near nape (Pl. I, fig. 2); region of eyes with lighter scales; 6 long, brown, curved bristles projecting over the eyes which are dark-wine-color or bronze in certain lights; antennæ sparsely setose, the setæ on each segment not more than 5 in number, being placed externally at the base of each; first segment covered basally with dark green, apically with white scales, second segment swollen basally, 1½ length of succeeding segments and having a dorso-internal tuft of greenish-brown scales on basal half only; other segments with dense, gray pile; palpi ¼ length of proboscis, *5-jointed* (Pl. I, fig. 3), first segment as long as wide; second, about four times length of first; third, nearly twice length of second; fourth and fifth, extremely small, their combined length being less than width of third and their width being less than ½ that of antepenultimate. The apex of the third segment is concave *not rounded*, and receives the fourth to half its length (Pl. I, fig. 4); scales of palpi dark purple, disposed in 2 groups giving the appearance of but 2 segments, the distal portion of each group is of white scales, those at the apex completely covering the fourth and fifth segments; third segment strongly laterally and apically spinose, there being 3 large spines at extreme apex extending beyond fifth segment (not shown in fig. 4). Fourth segment bears a single strong spine. The denuded palpus is moderately pilose (Pl. I, fig. 4), proboscis ⅔ length of body, when latter is normal (not shrunken), dark-purple or wine-color, with strong iridescence; the distal segment bilabiate with sensitively setose apex.

Prothoracic lobes strongly swollen, occupying angle between head and mesonotum, covered with scales of same color as those on head and with a vertical row of laterally projecting bristles; pronotum with dark-green, narrow, flat scales grading to very light-green laterally and cupreous on posterior margin; a single,

irregular patch of pure-white scales covers the pluræ; chetæ as follows: a downward and backward projecting group of brown bristles at middle of side of pronotum, a group of golden brown over root of wing, and an ill-defined group scattered between these two; scutellum with light-green, flat scales as on sides of pronotum and a marginal row of golden bristles; metanotum very dark-brown, longitudinally slightly sulcate on median line, and densely pilose.

Abdomen with green scales dorsally on basal segments, purplish or wine-colored on apical, first segment nearly all white, save a dorsal green patch; second and third, green with lateral white patch; fourth, nearly all green with faint suggestion of white laterally; fifth, as third but with some purplish scales and small white tuft; sixth and seventh, purplish, the former having lateral tufts of white and yellow, the latter, tufts of dark-brown; eighth segment, subtriangular, with green scales and yellow lateral tufts; venter, with purplish or violet-brown scales, the white patches of the dorsum being almost duplicated below, except on sixth segment, which is as fifth.

Legs variegated and banded; coxæ with large lateral patches of pure white scales, femora with dark-green and white areas, the anterior being all green, the middle internally whitish basally, the posterior, externally for nearly whole length; anterior tibiæ bluish-green externally with narrow, yellow stripe internally; mid tibiæ golden-yellow except at apex which is dark blue green and a mottled area externally at base, posterior tibiæ all dark-blue-green except a narrow, internal area in its middle; anterior metatarsi pure white with green at base; mid metatarsi the same, minus the blue-green at base, only a faint suggestion of which is left; posterior all dark-blue with white, mottled area over their basal third; anterior tarsi purplish brown-green except first, which is white for nearly its whole length, then brown; mid tarsi white, except last segment which is brown green; posterior tarsi same as anterior; ungues on all legs simple and of about same size.

Wings fuliginous, and irridescent, the veins having bluish-purple scales; first submarginal ½ length and ¼ width of second posterior cell, its proximal angle very acute, that of the second posterior rounded; mid cross vein nearer base of wing than posterior. (Pl. 1, fig. 10.) The cyclic vein very strongly developed and curving from end of vein 5 upward and inward in first anal cell, its branch curving downward and outward being partially parallel with wing margin. (Pl. 1, fig. 7.) Halteres basally swollen, pale-yellow; knobs lighter, with few dark scales. .

♂ similar in general coloring to ♀ except as follows: Scutellar bristles dark-brown, abdomen dorsally, dark-green basally to dark purplish-blue apically, second to fifth segments having only faint suggestion of white laterodorsally; anal tufts black in all segments except eighth which has a few golden bristles, more evident ventrally. Ventrum with white, lateral patches on fifth and sixth segments, occupying a total of ⅔ their width; on other segments a slight indication of these patches in form of a light line. Legs, with dark-blue green scales on all segments, a white longitudinal area on the posterior femora externally and internally. The mid and posterior metatarsi and first tarsal joints have light-green bands basally, otherwise all dark-blue-green. All legs in ♂ and ♀ strongly spinose with exception of tarsal segments.

The eyes of the ♂ are blue-black; the antennæ have first joints black, with white pruinescence, the second twice as long and 1.5 times as wide as any succeeding; all joints except last 2 with fine, brown pubescence and whorls of long, dense, brown bristles at their middle; last 2 joints filiform and setose with whorls of bristles from their bases; clypeus black with white pruinescence, its margin bicrenate; palpi very long, ⅔ length of body and slightly longer than proboscis, reflexed at their middle, *3-jointed* (Pl. 1, fig. 5) and strongly scaled, the

arrangement of the scales giving the appearance of 2 extra joints (Pl. I, fig. 6), the first segment composed of 3 anchylosed segments; general color, dark-blue-green with scattered light-green scales on dorsal aspect; distal segment, strongly acuminate and spined, as are the two preceding, at their apices only. Venation of wings as in ♀ except that mid cross vein and posterior cross vein are contiguous; supernumerary is farther removed from mid cross vein than in ♀. (See Pl. I, figs. 9 and 10 for arrangement of cross veins.) The posterior cross vein appears to be unstable in its position, varying in ♂ and ♀ in specimens other than the types, but the same relative position of the 3 veins is maintained in the sexes. Halteres basally swollen, ochraceous; knobs lighter with few dark hairs. Genitalia having basal segment bulbous and strongly spinose-setose, the distal segment long, slender, double-curved, the apical tooth being placed ventrally before apex. (Pl. I, fig. 8.) Length of ♂ 12–13 millimeters; length of wing 8.25–8.75 millimeters; length of palpi 7–7.5 millimeters.

NEGROS OCCIDENTAL, P. I., Bago, Hacienda "Louisiana," Mailum, alt., 150 meters; and CEBU, P. I., Cebu. (*Banks, McGregor, Coll.*)

Time of flight, June, July; adults from bred specimens, 24 June, 1906.

Types of ♂ and ♀, No. 6071 in Entomological Collection, Bureau of Science, Manila, P. I. There are 18 cotypes in the collection.

The name of this species is suggestive of the fact that aside from its beautiful appearance, it not only *does not bite*, but its larvæ destroy enormous numbers of noxious forms of *Culicidæ*, having fed most willingly upon those of *Culex fatigans* Wied., *Stegomyia scutellaris* Walk., var. *samarensis* Ludl., and *S. fasciata* Fabr., *var. nov.*, in the laboratory and in their natural habitat, upon those of at least two other, as yet unidentified, species, one of which is probably *Desvoidya* sp. This insect has been reared and is very easy to breed. A full description of its life history and habits will soon be published.

ILLUSTRATIONS.

PLATE 1.

FIG. 1. *Worcesteria grata* gen. et sp. nov., typical scale from occiput. × 400.
2. Bastonate scale. × 400.
3. Palpus of female. × 45.
4. Same showing apex of third segment and fourth and fifth segments. × 200.
5. Palpus of male showing mid-stricture of first segment and remains of anchylosed joint near base of same. × 15.
6. Palpus at middle of its first segment showing stricture and arrangement of scales to give appearance of articulation. The same scale arrangement is found at base of first segment. × 105.
7. Margin of wing showing position of cyclic vein. × 45.
   a. Fifth longitudinal vein.
   b. Sixth longitudinal vein.
   c. Cyclic vein, with its branching.
8. Male genitalia showing basal and distal segments, the latter bearing apical ventral spines, and the harpes shown between basal segments as two outward curving hooks. × 50.
9. Arrangement of supernumerary and cross veins in male. × 45.
   I. Supernumerary.
   II. Mid cross vein.
   III. Posterior cross vein.
10. The same of the female. The arrows in each case point toward apex of wing. × 45.

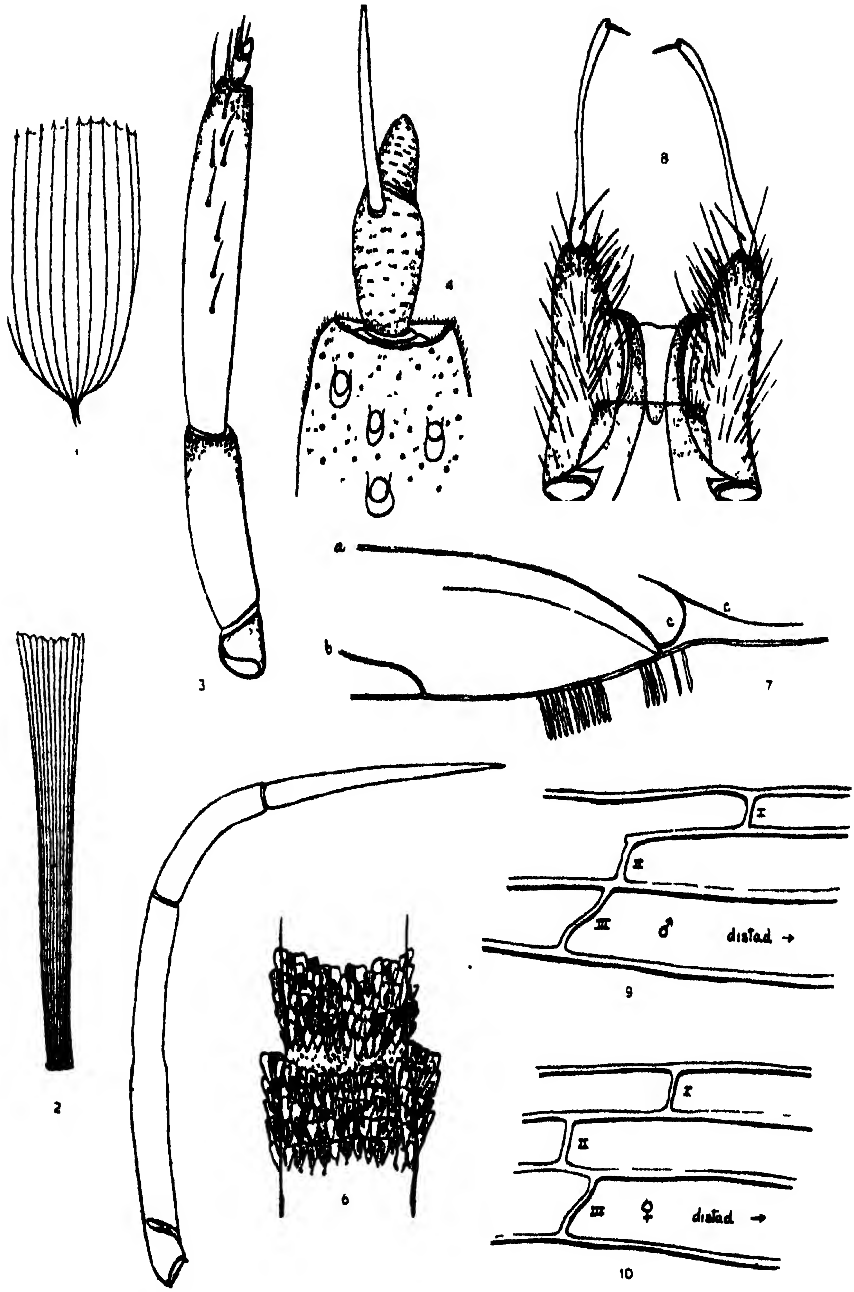


PLATE I

A CHANGE OF NAME IN COCCIDÆ.

By CHARLES S. BANKS.

Since the publication of descriptions of certain new species of *Coccidæ* in THE PHILIPPINE JOURNAL OF SCIENCE (1906), I, 230 *et seq.*, my attention has been called to the fact that *Chionaspis candida* had already previously been used by Green in the description of a species from Australia.[1]

In consequence of this previous use of the name *candida*, I propose to change the name of my species to *Chionaspis inday*[2] Banks in place of *Chionaspis candida* Banks as given on page 232 of THE PHILIPPINE JOURNAL OF SCIENCE and also on page 222 of the JOURNAL in Part II of "The Principal Insects Attacking the Coconut Palm."

[1] *Victorian Naturalist* (1905), **22**, 6.

[2] Inday (pron. *in dic*): A Visayan term meaning "little one."

REVIEWS.

The World's Anatomists: Concise Biographies of Anatomic Masters, from 300 B. C. to the Present Time, Whose Names Have Adorned the Literature of the Medical Profession. By G. W. H. Kemper, M. D., Professor of the History of Medicine in the Medical College of Indiana. Revised and enlarged. Paper; 11 illustrations, 9 of which are portraits. Pp., xiv + 79. Price, $0.50. Philadelphia: P. Blakiston's Son & Co., 1905.

This small book will find a place on the table of the anatomist or of the general scientific worker in biological subjects, as a concise tabulation of the names and of a few important facts in the careers of a number who have worked in the field of anatomy.

It will also serve to assist somewhat in the study of nomenclature. For the student of the history of medicine it will be of but little value, as it is a tabulation and not a discussion from the historical standpoint.

Treatise on Diseases of the Skin for the Use of Advanced Students and Practitioners. By Henry W. Stelwagon, M. D., Ph. D. Fourth edition, thoroughly revised. Cloth, 258 illustrations in the text and 32 full-page lithographic and half tone plates. Pp., 1136 Philadelphia: W. B. Saunders & Co., 1905.

Stelwagon's Treatise on Diseases of the Skin would appear peculiarly adapted to the use of the general practitioner by reason of the clear and concise manner in which the various affections are described. A happy faculty of paragraphing, and in this way of presenting separately the important questions to be considered in understanding a disease, gives one a comprehensive grasp of the disease entity which is not always obtained in works on skin.

The fourth edition of this excellent work is filled with plates and illustrations which greatly assist one who is not a specialist in this branch of medicine and the lack of which makes certain other similar volumns less well adapted to the use of the man in general practice.

The paragraphs on diagnosis, under the heads of psoriasis and eczema, impress one as most clearly expressed, and the entire article on eczema is clear and to the point. The discussion of tuberculosis of the skin and that of syphilis are of great practical value, and many of the illustrations under these subjects are more instructive than columns of written matter would be. The affections due to parasitic yeasts and molds are briefly but well presented, the article on blastomycetic dermatitis being particularly satisfactory.

However, many of the diseases in which those working in the Tropics are peculiarly interested receive little more than brief mention. Thus, under the discussion of Delhi boil, or tropical ulcer, there is not even a reference to the work of the various recent investigators of the etiology of these widespread affections, no mention being made of the work of Wright, Strong, or James.

Dhobie itch, the skin affection which in so many of the tropical countries peculiarly impresses its characteristics upon the tourist, is described in a general and rather misleading way.

After all is considered, it is necessary to admit that it would be difficult to conceive of a work more to be recommended for the purpose designated in the preface, namely, as a guide for those engaged in general practice.

E. R. S.

THE PHILIPPINE JOURNAL OF SCIENCE.

During the coming year a series of articles on ethnological and ethnographical subjects will appear in the Philippine Journal of Science. The first article of this series appears in this number of the Journal. The following additional papers will certainly be available:

1. The Non-Christian Tribes of Southern Luzon, with Map Showing Distribution of Non-Christian Tribes throughout the Entire Island of Luzon; by Dean C. Worcester.
2. The Tagbanua and Mangyan Alphabets; by Dr. T. H. Pardo de Tavera.
3. The Subanos of the Zamboangan Peninsula; by Edwin B. Christie.
4. Primitive Philippine Fire-Making Apparatus; by Dean C. Worcester.

This entire series of ethnological and ethnographical papers will be of fundamental importance to all who are interested in the peoples of the Philippine Islands.

THE PHILIPPINE

JOURNAL OF SCIENCE

VOL. I OCTOBER, 1906 No. 8

THE NON-CHRISTIAN TRIBES OF NORTHERN LUZON.

By DEAN C. WORCESTER.

(*From the office of the Secretary of the Interior, Manila, P. I.*)

INTRODUCTION.

In this article the words "Northern Luzon" are used to designate that portion of the island lying north of a line drawn due east from the city of Manila to the Pacific coast.

Great confusion exists as to the classification and geographical distribution of the non-Christian tribes inhabiting this area. It would be impracticable, within the limits of a brief article, to discuss all of the different classifications which have heretofore been proposed and I shall confine myself to three of the latest and most authoritative. In 1882 Prof. Ferdinand Blumentritt published his "Versuch einer Ethnographie der Philippinen," in which he recognizes one race and tribe, the *Negritos,* and a second race, the *Malays,* which he subdivides into twenty-three tribes. His classification by tribes stands as follows:

1. THE NEGRITOS.

   Habitat: Principe, Isabela, Cagayan, North and South Ilokos, Abra, Pangasinan, Zambales, and Bataan.

2. IGORROTES.

   Habitat: Benguet, Lepanto, including the district of Tiagan and Bontoc

3. BURAGS.

   Habitat: The northern part of Tilas Cordillera, Tiagan, the northern half of Lepanto and Bontoc on the northern waters of the Rio Cagayan,

4. ALTASANES and ILIMUTES.

   Habitat: Nueva Viscaya.

5. **Bujuanos.**

Habitat: Isabela.

6. **Panuipuyes.**

Habitat: Nueva Vizcaya and Isabela. "Perchance only a branch of the Mayoyaos."[1]

7. **Isinays.**

Habitat: The middle course of the Agno River.

8. **Ibilaos.**

Habitat: The region extending from the border line between Nueva Vizcaya and Nueva Ecija to the vicinity of Baliran.

9. **Ilongotes.**

Habitat: Nueva Vizcaya, Isabela, Principe and northern Nueva Ecija.

10. **Mayoyaos**; also called **Quianganes**, **Punoianes**, and **Silipanes.**

Habitat: Southern and eastern Bontoc and northern Nueva Vizcaya.

11. **Ifugaos.**

Habitat: Left bank of the Magat River to the south and southwest from Fural between Mayoyao and Camarga in Nueva Vizcaya.

12. **Gaddanes.** (A considerable number of this tribe christianized.)

Habitat: The region between the Magat River and the Rio Chico.

13. **Itetapanes.**

Habitat: The territory to the east of the *Busaos* and the west of the *Gaddanes*.

14. **Guymanes** (**Quymanes**, **Quiamanes**).

Habitat: Territory north of the *Busao Igorots*, especially the eastern slopes of the Cordillera which separates the Province of Abra from Cagayan; the right bank of the Abra River to the left of the Pusulgan River marks the western limits reached by them.

15. **Calaus** or **Itaves.**

Habitat: Western Cagayan from Piat and Tuao on the south to Malaueg on the north.

16. **Gamunanges** and **Bayabonanes.**

Habitat: Mountains east and north of Tuao, Province of Cagayan; may be a branch of the *Dadayags*.

17. **Dadayags.**

Habitat: Left bank of the middle portion of the Rio Grande, Province of Cagayan, extending into the heights near Cabagan.

18. **Nabayuganes.**

Habitat: Region to the west of Malaueg on one of the northern affluents of the Rio Chico, Province of Cagayan.

19. **Aripas.**

Habitat: Region between the Nagsiping and Tubang to the south of the union of the Rio Grande and Rio Chico, Province of Cagayan; also the southern part of the mountain range which forms the watershed between the Rio Grande de Cagayan and the Rio Apayao.

20. **Calingas.**

Habitat: The mountains where the *Aripas* dwell and farther north.

[1] Blumentritt: *Versuch einer Ethnographie der Philippinen* (1882), 22.

21. TINGUIANES (ITANEGAS, TINGGIANES, TINGUES).

Habitat: From Candon in Ilokos Sur to Mount Pacsan on the border line between Cagayan and Ilokos Sur; also extending south to the neighborhood of Santa Cruz and Namacpacan, so that they inhabit the Provinces of Ilokos Sur, Abra, and Ilokos Norte.

22. APAYAOS.

Habitat: Valley of the Apayao River and northern portion of eastern slope of the mountain chain which separates the Province of Cagayan from Ilokos Norte, extending south to Malaueg.

23. CATALANGANES.

Habitat: Catalangan River, one of the right branches of the Rio Grande, in the Province of Isabela.

24. IBAYAS.

Habitat: The region to the south of the *Catalanganes*, chiefly on the west side of the Cordillera of Palanan.

In 1890 Professor Blumentritt published his "Alphabetisches Verzeichniss der eingeborenen Stämme der Philippinen und der von ihnen gesprochenen Sprachen." This list differs from that published in 1882 in the following particulars:

The *Altasanes* and *Alimut* are given as separate tribes, as are the *Bayabonanes* and the *Silipanes*, while the following tribes not mentioned in his first list are added:

ABUNLON

Habitat: Mountains of Zambales.

BUNGANANES.

Habitat: Isabela and Nueva Vizcaya.

IFUMANGIES.

Habitat: Nueva Vizcaya.

ILAMUT.

Habitat: Vicinity of Quiangan, Nueva Vizcaya.

ILEABANES.

Habitat: Nueva Vizcaya.

ITALONES.

Habitat: Mountains of Nueva Vizcaya.

JUMANGIS.

Habitat: Central (?) Luzon.

PUNGIANES.

Habitat: Not given.

The total number of tribes recognized by Professor Blumentritt is thus raised to thirty-six.

In 1899 a number of priests of the Jesuit mission of Manila collaborated to produce, for the use of the first Philippine Commission, a very full account of the Philippine Islands, their resources, and their people.[2]

[2] Published in *Report of the Philippine Commission* (1900), 3, 333-412.

They recognized three races, the *Negrito,* the *Indonesian,* and the *Malay,* of which only the *Negrito* and the *Malay* were believed by them to be represented in northern Luzon. The Malay race they divided into three subraces—the *Malay-Negritos,* the *Malay-Chinese,* and the *Malay-Mohammedans.*

In order to facilitate comparison, I give these two lists in tabulated form:

Name of tribe.		Habitat.
Blumentritt's list.	Jesuit list.	
1. Abunlon	1. Abunlon	Mountains of Zambales.
	2. Aetas	Pangasinan and Zambales.
2. Adang	3. Adaugtas	Mount Adang in North Ilokos.
3 Alimut		Quiangan (?), Nueva Vizcaya.
4. Altasanes		Northwestern Nueva Vizcaya
5. Apayaos	4. Apayaos	Northwestern Cagayan and neighboring parts of North Ilokos and Abra.
6. Aripas	5. Aripas	Near Nacdiping and Tubang, Cagayan
7. Bayabonan		Mountains east of Tuao, Cagayan.
	6. Attas	Eastern mountain chain of Cagayan, down to the Pacific coast.
8. Bujuanos		Isabela
9 Bunganaues		Nueva Vizcaya and Isabela.
	7. Balugas	Eastern cordillera of Nueva Ecija, mountains bordering on Tarlac and Pampanga; Cordillera of Zambales, eastern mountains of North and South Ilokos.
	8 Buquiles	Zambales
	9. Buries	Abra
10. Busaos	10. Busaos	Siguey mountains, Abra, near Benang (Jesuits).
11 Calauas	11. Calauas	Valley of the Rio Chico near Malaueg, Cagayan.
12. Calingas	12 Calingas	Between the Rio Grande de Cagayan and the Ablug River
13. Catalanganes	13. Catalanganes	Watershed of Catalañgan River, east of Ilagan, Isabela.
14. Dadayag		Mountains west of Cabagan, Cagayan.
	14. Dumagas	Mountains from Baler and Casiguran to Cape Engaño
15. Gamungan		Mountains east and north of Tuao, Cagayan.
16 Guinaanes	15. Guinaanes	Watershed between Abra River and Rio Grande de Cagayan. Border territory between Isabela and Abra
17. Ibilaos	16. Ibilaos	Border territory of Nueva Vizcaya and Nueva Ecija.
18. Ifugaos	17. Ifugaos	Nueva Vizcaya and Isabela (Blumentritt). Missions of Ituy and Paningui, eastern Carraballos (Jesuits).
19 Ifumangies		Nueva Vizcaya.
20 Igorrotes	18 Igorrotes	Benguet and Lepanto (Blumentritt). Abra, Pangasinan, Nueva Vizcaya, Zambales, and Pampanga (Jesuits).
21 Ilamut		Nueva Vizcaya in cordillera forming boundary with Benguet.
22 Ileabanes		Nueva Vizcaya.

Name of tribe: Blumentritt's list.	Name of tribe: Jesuit list	Habitat.
23. Ilongotes	19. Ilongotes	Boundary region of Nueva Vizcaya and Principe, also Nueva Ecija
24. Irayas	20 Irayas	Western slopes of the cordillera of Palanan (Blumentritt) Banks of River Ilaron and eastern slopes of Sierra Madre on the side of Nueva Vizcaya, Isabela, and Cagayan (Jesuits)
25. Isinays	21 Isinays	Nueva Vizcaya (Blumentritt). Panay (Jesuits)
26 Italones	22 Italones	Nueva Vizcaya
27. Itetapanes	23 Itetapanes	Western Isabela and possibly Bontoc (Blumentritt) Territory east of the Busaos, bounded on the south by the Igorrotes of Benguet and on the north by the Guinaanes (Jesuits)
28 Jumangi		Central (?) Luzon
29 Mayoyaos		Southwest corner of Isabela and northwest corner of Nueva Vizcaya
30. Nabayuganes		Territory west of Malaueg Cagayan
31 Negritos	24 Negritos	Different parts of Luzon (Blumentritt). Bataan, North and South Ilokos, and Nueva Ecija (Jesuits)
32 Panuipuyes		Western Nueva Vizcaya or Isabela
33 Punglanes	--------	Not given
34 Quianganes	25 Quianganes	*Comandancia* of Quiangan, Nueva Viscaya
35. Silipanes	----- --- --	Do
36 Tinguianes	26 Tinguianes	Abra and North and South Ilokos (Blumentritt) Cordillera of Tila and Province of Abra (Jesuits)

It will be noted that the Jesuits enumerate but twenty-six tribes while Blumentritt lists thirty-six. The *Alimut, Altasanes, Bayabonanes, Bujuanos, Bunganianes, Dadayag, Gamungan, Ifumangies, Ilamut, Ilcabanes, Jumangi, Mayoyaos, Nabayuganes, Panuipuyes, Punguanes*, and *Silipanes* do not appear in the Jesuit list, and on the other hand the *Aetas, Attas, Buquiles, Burics, Balugas*, and *Dumagas* of the Jesuit list are omitted by Blumentritt, and rightly so, as all of these peoples except the *Burics* are Negritos, while the word *buric* means *tattooed* or *painted* and is used in describing certain tattooed persons. It is not a tribal name.

In 1902 Dr. David P. Barrows, at that time Chief of the Bureau of Non-Christian Tribes, wrote for the Census of the Philippine Islands a history of the non-Christian tribes of the Philippines[1] in which he makes the following statement:

> One impression that has gained foothold in regard to the tribes of the Philippines I believe to be erroneous, and that is as to the number of distinct types or races and multiplicity of tribes. Owing to the fact that nowhere in the Philippines do we encounter large political bodies or units, we have a superlative number of designations for what are practically identical people. The tribe itself

[1] *Census of the Philippine Islands of 1903* (1905), 1, 453–477.

as a body politic is unknown in this Archipelago. The Malayan has never by his own effort achieved so important a political organization. Such great and effective confederacies as we find among the North American Indians are far beyond the capacity of the Filipino of any grade. For example, among the powerful and numerous Igorot of northern Luzon the sole political body is in the independent community. * * *

Errors in nomenclature prevail everywhere in the Islands. Sometimes three or four different terms have been applied by different localities or towns to identical peoples, and all these designations have gone to swell the reputed number of Philippine tribes. Thus Blumentritt credits fully eighty-two such distinct tribes; the Jesuits, who have been diligent collectors of information here, as everywhere, report sixty-seven tribes, and the enumerators for the census turned in on their schedules a total of about one hundred and sixteen different or differing titles, which had to be explained and reduced to system.

Dr. Barrows, in his history, adopts the following classifications for the tribes of northern Luzon:

NEGRITO RACE.

Tribe, NEGRITOS. (Synonyms: ITA, ETA, AGTA, BALUGA, DUMAGAT, ABUNLON.)

Habitat: Cagayan, Isabela, Ilokos Norte, Abra, Nueva Vizcaya, Tayabas (Principe and Infanta), Nueva Ecija, Bulacan, Rizal, Pangasinan, Tarlac, Zambales, Pampanga, and Bataan.

MALAY RACE.

Tribe, IGOROT.

Habitat: The Cordillera Central from the extreme north of Luzon to the plains of Pangasinan and Nueva Ecija.

Under *Igorot*, he employs various dialect group designations such as the *Gaddang*, *Dadayag*, and *Mayoyao*, said to be divided solely by slight differences of dialect. He states that the exact number of these groups has not thoroughly been worked out, but that he has personally studied and collected vocabularies of twelve and believes that this number includes all except minor variations and one branch in the extreme north of the cordillera, called *Apayaos*. This last people, he says, is on both slopes of the cordillera, but far more numerous on the Cagayan side.

Referring further to these dialect groups of people, he mentions the following:

DADAYAG.

Habitat: The head waters of the Rio Chico de Cagayan in Itaves district, Cagayan Province, where they occupy the low foothills of the Cordillera Central.

GADDANG.

Habitat: The region farther south, along the same foothills as the *Dadayag*, extending through Isabela.

KALINGA.

Habitat: The region east of the *Dadayag* and *Gaddang*.

BANAOS.

Habitat: The region midway between Balbalasan and Labuangan, as well as the Saltan River valley, all in the Province of Bontoc. They are regarded by Dr. Barrows as the prototype of the present more civilized *Tingian*.

Bunnayan.

Habitat: Western part of old Spanish *comandancia* of Quiangan.

Silipan.

Habitat: Eastern part of old Spanish *comandancia* of Quiangan.

Mayoyao.

Habitat: Region on dividing line between Quiangan, in the Province of Nueva Vizcaya, and the Province of Isabela.

Isanay.

Habitat: Mountains west of the civilized portion of Nueva Vizcaya.

Tinguians.

Habitat: Abra and eastern mountains of Ilokos Sur and Ilokos Norte.

Kankanay.

Habitat: Northern Benguet and Amburayan.

Nabilol.

Habitat: Southern Benguet and the district of Kayapa of the same province.

Dr. Barrows states that for the purpose of ethnological classification all these peoples represent one group. He then discusses what he terms a very curious tribe of head-hunters known among the people of Nueva Vizcaya as *Ibilao* but sometimes designated as *Ilongot.*

Habitat: Head waters of the Rio Grande de Cagayan in Isabela Province, Caraballo Sur Mountains, thence southeast through the mountainous portions of Nueva Ecija and Principe.

This tribe he apparently does not regard as one of the "Igorot peoples."

He next refers to the nomadic Malayan families living southward in the montainous country north of Rizal Province and occurring also in Ambos Camarines, Negros, and Panay. These people are designated by him a wild "type," and with other peoples are included under the designation *Bukidnon.* If he gives the *Bukidnon* tribal rank, as he apparently does, Dr. Barrow's classification stands as follows:

Race	Tribe	Dialect groups.
1 Negrito	1 Negrito.	
2. Malay	2 Igorot	Gaddang. Dadayag Mayoyao Kalinga Banaos. Bunnayan Silipan Ganay. Tinguians. Kankanay. Nabilol Apayaos.
	3. Ilongot.	
	4. Bukidnon.	

I am in entire accord with all that Dr. Barrows has said relative to the superabundance of tribal designations. In a number of instances, two or more have been given to the same tribe. The names *Ibilaos* and *Ilongotes*, for instance, are clearly two distinct designations for a single people. However, I am of the opinion that there is another and much more important source of error. It is undoubtedly true that the ideas which existed among the Spaniards as to the meaning of the word "tribe" were rather vague. Throughout the Cordillera Central the *rancheria* or settlement is the social and political unit. In the head-hunting countries *rancherias* of people of the same tribe were constantly at war with each other, and the blood feuds between them were handed down from generation to generation. As a result, intercourse between these *rancherias* was more or less completely cut off for scores of years. It was unavoidable that differences of dialect should develop under such circumstances.

Further study of the peoples of northern Luzon has shown that such variations have appeared to a greater extent than Dr. Barrows had been led to believe.

It was the usage of the Spaniards to designate as a tribe each group of people which had a dialect, more or less peculiar, of its own. Furthermore, the custom which is widespread among the hill people of northern Luzon of shouting out the name of a settlement when they desire to call for one or more persons belonging to it, seems in many instances to have led the Spaniards to adopt settlement names as tribal ones, even when there were no differences of dialect between the peoples thus designated.

In criticising Professor Blumentritt's classification, it must be remembered that he has never visited the Philippine Islands. He is a compiler, pure and simple, and when preparing his list of Philippine tribes has been compelled to follow, more or less blindly, the persons from whom he has derived his information. After nearly four centuries of Spanish occupation and rule, extensive areas in northern Luzon remained entirely unexplored at the time of the American occupation, and it has proved a simple matter to find, in the northern part of the Cordillera Central, extensive river valleys within which the face of a white man had never been seen prior to that date. The alleged facts as to the inhabitants of this region were necessarily hearsay when they reached the Spaniards, and second-hand hearsay when they reached Professor Blumentritt.

At the time their list of Philippine tribes was prepared, the Jesuits had never occupied missions in northern Luzon, and no explorations had been made by the Americans in that part of the island, so that they were forced to digest, as best they could, the miscellaneous mass of information prepared for them by Blumentritt and other writers.

Dr. Barrows had the benefit of personal acquaintance with many of the peoples concerning whom he wrote.

In July, 1902, he left Baguio, in the Province of Benguet, and traveled north by way of Tublay, Kapangan, Balakbak, Kibungan, and Palina. Crossing into

Amburayan he visited Bokong, Tubaoo, Bagu, Balbalit, Lameo, Buanis, Amilugan, Bais and Alilem, the capital of the subprovince. From Alilem he went to the coast and north to Candon, thence to Salcedo, and by way of Barakbak and Paltog to Tiagan; thence to Angaki and Cervantes, returning to Baguio by way of Buguias and Daklan.

On September 24 of the same year, Dr. Barrows, accompanied by Dr. Albert E. Jenks, again left Baguio for the north. They proceeded to Ambuklao and the old *comandancia* of Kayapa, visiting Losod, Wagan, and Limus in the latter region. Thence they went to Dupax in Nueva Vizcaya, passing through the country of the few remaining uncivilized *Isinays*. From Dupax they traveled to the Ilongot *rancheria* of Baiyait, and thence to Quiangan by way of Bagabag. From Quiangan they proceeded to Lagani, Banao, and Libung, returning to Bagabag and crossing the mountains to Echague and Ilagan in Isabela. From the latter place they went by the Catalañgan River to San Mariano, visiting various *Negrito* and *Kalinga* rancherias. Returning to Ilagan, they traveled to Cabagan Nuevo and thence to Bulana, the old mission station of Itaves, passing through the country of the *Dadayags;* thence to Amiao, Nanung, and Minanga, all on the Rio Chico; thence to Kagalwan, and over the divide to Ablug in the subprovince of Bontoc. From Ablug they went by way of Laguagan, Tokukan, and Butbut to Sakasakan; thence to the *rancheria* of Bontoc, returning to Baguio by way of Sagada, Cayan, Cervantes, Loo, Buguias, Adaoay, Kabayan, Daklan, and Ambuklao.

On other occasions Dr. Barrows has also traveled extensively in southern Benguet and in Abra.

He was necessarily impressed with the absurdity of applying the host of tribal names which had been assigned them to the peoples with whom he came in contact, and in preparing his "history" he very properly attempted to reduce the number in use. It does not appear, however, that he had clearly in mind a definition of the word "tribe," and we find him dividing the people into "tribes," "types," and "dialect groups," without informing us what he means by any of these terms.

Apart from this confusion of terminology, any classification which unites such strikingly different peoples as the peaceable, industrious, and highly civilized *Tingians* of Abra, the long-haired, warlike, head-hunting *Igorots* of Bontoc, the short-haired, head-hunting peoples of Banaue, Silipan, and Mayoyao, and the fierce and wild *Kalingas* in one "ethnological group" seems to me fundamentally wrong. These peoples differ in many of their physical characteristics; in the manner in which they group their habitations; in their dress and manner of wearing their hair; in their tattoo patterns; in their architecture and industries; in their music and dancing; in their religious ceremonies; in their methods of head-hunting and in the ceremonies which follow successful head-hunts, and in their customs relative to marriage and the burial of the dead. While I am far from denying that they may have had a common origin, or for that matter that their origin and that of the civilized tribes of northern Luzon may, in the remote past, have been a common one, I do maintain that any ethnological classification which groups together such radically distinct peoples fails in the main object of such classification.

In addition to the explorations made by Dr. Barrows and Dr. Jenks,

other extensive and important investigations have been carried on relative to the non-Christian tribes of northern Luzon.

Dr. M. L. Miller, now Chief of the ethnological division of the Bureau of Education, on November 3, 1904, left San Fernando, in the Province of Union, and proceeded up the coast to Candon in South Ilokos. In the vicinity of Candon he visited twenty-two *Tingian rancherias*.

From this place he again proceeded along the coast northward to Badoc and Paoay, and near Badoc visited the *Tingian* settlement of Uguis. Returning to Vigan, he went up the Abra River to Bangued, and thence to Pilar by way of Catebongan, visiting the *Negrito* settlement near the latter place. From Pilar he passed through the settlements of San José, San Guillermo, Tui, and Balbalasan to Guinaan. From Guinaan he proceeded to Baguio by way of Labuagan, Tinglayan, Bontoc, Cervantes, Mancayan, Loo, Bugias, Daklan, and Ambuklao.

On January 31, 1906, he went to Capas, in the Province of Tarlac, and thence to O'Donnell and Iba in Zambales. Between Iba and Santa Fe he visited five *Negrito* settlements, and afterwards Aglao, an *Ilokano* settlement. He then crossed over the mountains through *Negrito* territory to Florida Blanca. In February of the same year he traveled to Tarlac and visited a *Negrito* settlement near Mangatarem.

In April, 1906, he went to San Isidro and Cabanatuan, in Nueva Ecija, and thence to Baler on the Pacific coast, passing through the country of the *Ilongots* and *Igorots*.

Capt. Charles E. Nathorst, of the Philippines Constabulary, lived for some time among the *Igorots* in southern Lepanto and, since his appointment as a Constabulary officer, has traveled very extensively in the mountain country of northern Luzon.

He has visited the Bontoc *Igorot rancherias* of Amboan, Barlig, Lias, and Balangao in southern and eastern Bontoc, bordering on Nueva Vizcaya; the *Kalinga rancherias* of Lubo, Mangali, Taloctoc, Tanglac, Liclic, Balantey, Bolo, Saleesec, Calogney, Damijon, Dalugen, Boök, Patiquian, Linas, and Baneng, which are in eastern, northeastern, and northern Bontoc, bordering on Cagayan, and also the *rancherias* of Seseean, Talalan, Balbalasan, Pasqual, and Innanungan, in northern and northwestern Bontoc. These *rancherias* have a mixed population, composed largely of *Tingians* who have intermarried to some extent with Bontoc *Igorots*, and *Kalingas*.

Captain Nathorst has been informed that south of Lubo is a *Kalinga rancheria* called Gaiin, and south of Gaiin an *Ifugao* one called Dakalan, on the border of Isabela.

Capt. Samuel D. Crawford, who accompanied me from Laoag in North Ilokos to Ablug in Cagayan in 1906, has also made numerous expeditions of his own through the mountains of northern Luzon.

Lieut. L. E. Case, of the Philippines Constabulary, was stationed at Banaue in Nueva Vizcaya from January, 1903, to July, 1906, and visited nearly every *rancheria* in the northwestern part of that province.

My own more important trips through northern Luzon have been as follows:

In 1900: Manila to Baguio, Benguet, and return by way of San Fernando.

In 1901: Manila to Pozorubio, in Pangasinan; thence to various settlements of "new Christians," who proved to be *Tingians*, in the foothills of the Benguet

mountains in the vicinity of Pozorubio and Rosario; thence to Baguio, Benguet, by way of the coast route in Union, and the Naguilian trail; thence north by way of the *Igorot* settlements of Ambuklao, Daklan, Kabayan, Buguias, Adaoay, Loo, Suyok, and Mancayan to Cervantes; thence to the coast and Manila, passing through the *Igorot* settlements of Angaki and Concepcion en route.

In 1903: Manila to Bangued, the capital of Abra, from which point numerous *Tingian* settlements were visited; thence to Cervantes in Lepanto, by way of the *Tingian* settlements of Tiagan and Angaki; thence to Bontoc by way of the Lepanto *Igorot* settlements of Kayan and Bagnan, and the Bontoc *Igorot* settlement of Sagada; thence to the Bontoc *Igorot* settlement of Mayinit and return; thence to the Bontoc *Igorot* settlements of Talubin and Ambuan; thence through the mountain range to the *Ifugao* settlement of Banaue, in Nueva Vizcaya, returning to Bontoc; and thence by another route through the Bontoc and Lepanto *Igorot* settlements to Kayan; thence by the route previously traveled to Cervantes, and through Benguet to Baguio and Manila.

In 1905: From Manila to Bangued in Abra; thence to the *Tingian* settlements of Manobo, San Andres, and Tui; thence over the Cordillera Central to Balbalasan, and down the valley of the Saltan River through Sesecan and Patiquian to Saleesee; thence north, through the *Kalinga* settlements of Gannaäu and Ubel; thence over a spur of the Cordillera Central to Mabaca, Umbali, Bunuan, and Balanga, and down the hitherto unknown Mabaca River by way of Lapoc, Kalaling, Madadnao, Kalaoang, Bagnang, Bontoc (a small Kalinga *rancheria*, not the capital of the subprovince of the same name), Took Took, Manongnong, Asiga, Uaged, Malagnat, Ammasian, and Pinakpook (Pinecpec); thence to Tuao and Tuguegarao, in Cagayan, and up the Rio Grande to the *Ilongot* settlement of Dumabato in southern Isabela; thence by way of Echague and Carig to Bayombong, the capital of Nueva Vizcaya, north through the Quiangan and Banaue settlements and over the Polis range, to Bontoc, returning by the usual route to Baguio and Manila.

In 1906: From Manila overland to Laoag, in Ilokos Norte; thence to Piddig, and thence by river bed and trail over the Cordillera Central to Dallaoas, in Apayao; thence down the Ablug River, through the *rancherias* of Dallaoas, Cabugaoan, Lapoc, Ablul, Naguilian, Nagtuyangan, Dibagat, Palocago, Dipadi, Nacagman, Madatag, Tamogac, Cabotot, Pili, Masimut, Locab, Nagbabalayan, Nagsimbangan, Cabugaoan (there are two *rancherias* of this name on the Ablug River), Atanani, Magapta, Bolo, Uaga, Punciau, Guenned, Bubulayan, Burayangan, Tauit, and Maculaling, to Ablug; thence to Aparri, and by way of the Rio Grande to Ilagan and Gamu, in Isabela Province; thence to the *Kalinga rancheria* of Sili and the *Ifugao rancherias* of Mayoyao, Ayangan, and Banaue; thence to Bontoc, Baguio, and Manila by the usual trail.

Governor Blas Villamor, who accompanied me on my 1905 and 1906 trips, has visited practically every settlement of non-Christians in his province and has made the direct journey overland from Ilagan and Santa Maria in Isabela Province, to Bangued, in Abra, stopping en route at many *Kalinga* and *Ifugao rancherias*.

Capt. Henry Knauber, of the Philippines Constabulary, has made numerous trips northward and westward from Malaueg, in the Province of Cagayan, has thoroughly explored the *Kalinga* country between Malaueg and Nagsimbangan on the Ablug River, and has ascended the river for some distance above the latter point.

It should further be remembered that there are organized and effective

governments in Benguet, Nueva Vizcaya, and in the subprovinces of Amburayan, Lepanto and Bontoc, which collectively form the Province of Lepanto-Bontoc. Governor Pack, of Benguet, and Lieutenant-Governor Hale, of Amburayan, have repeatedly visited every settlement under their jurisdiction. Governors Dinwiddie and Reed have done the same in Lepanto, as have Lieutenant-Governors Folkmar and Eckman in Bontoc. In Nueva Vizcaya there remains practically no unexplored territory, thanks to the efforts of Governors Johnson, Bennett, and Knight, and of Lieutenant Case.

While the census enumeration of 1903 was in progress, a special effort was made to ascertain the truth about the non-Christian tribes of the Philippines, and much valuable information was obtained relative to those of northern Luzon.

It is not too much to say that hardly a *rancheria* now remains in the Cordillera Central and its foothills, except in the district of Apayaos, which has not been visited by Americans, while even in the latter district twenty-nine of the more important *rancherias* have been visited. As a result of these recent explorations, a large amount of reliable information has been gathered, and it is upon this information and upon personal observations that the conclusions hereinafter set forth are based.

Doubtless much of the present confusion as to the tribes of northern Luzon is due to the fact that those who have written concerning them have used the word "tribe" with very different meanings. I will, at the outset, endeavor to make plain the sense in which I employ it.

The Century Dictionary and Cyclopedia describes "tribe" as follows:

> *Tribe:* (1) In Roman history, one of the three patrician orders, or original political divisions of the people of ancient Rome, the Ramnes, Tities, and Luceres, representing respectively, according to tradition, the separate Latin, Sabine, and Etruscan settlements, having at their union equal representation in the senate and retaining their distinctive names for several centuries. Hence, (2) any one of the similar divisions of a race or nation common in antiquity, whether of natural or of political origin: as the tribes of Athens. (Ethnical tribes among the ancients regarded themselves as enlarged families, and generally bore the name of some real or supposed common progenitor. Such were the twelve tribes of the Israelites, the tribes of the Dorians and other Greek races, etc.) (3) Specifically, a division of a barbarous race of people, usually distinguishable in some way from their congeners, united into a community under a recognized head or chief, ruling either independently or subordinately. In general, the tribe, as it still exists among the American Indians and many African and Asiatic races, is the earliest form of political organization, nations being ultimately constituted by their gradual amalgamation and loss of identity in the progress of civilization. The characteristic of all these races (Uralian), when in the tribal state, is that the tribes themselves, and all subdivisions of them, are conceived by the men who compose them as descended from a single male ancestor. In some cases the tribe can hardly be otherwise described than as a group of persons taken collectively; any aggregate of individuals of a kind, either as a united body or as distinguished by some common characteristic or occupation.

Webster's International Dictionary gives the following definition of the word "tribe:"

Tribe: (1) A family, race, or series of generations descending from the same progenitor, and kept distinct, as in the case of the twelve tribes of Israel, descended from the twelve sons of Jacob. (2) A number of species or genera having certain structural characteristics in common. (3) A nation of savages or uncivilized people; a body of rude people united under one leader or government, as the tribes of the Six Nations; the Seneca tribe. (4) A division, class, or distinct portion of a people from whatever cause that distinction may have originated; as, the city of Athens was divided into ten tribes. (5) A family of animals descended from some particular female progenitor; as, the Duchess tribe of shorthorns.

Under the fourth alternative definition given in the Century Dictionary any one of the several classifications which have been adopted for the wild tribes of northern Luzon could be justified. On the other hand, were we to adopt any definition which includes as an essential feature the existence of a head or chief warrior of the tribe as a whole, we should be forced to the conclusion that there is no such thing as a tribe in the Philippines outside the territory occupied by the Moros.

I use the word in the following sense:

A division of a race composed of an aggregate of individuals of a kind and of a common origin, agreeing among themselves in, and distinguished from their congeners by physical characteristics, dress, and ornaments; the nature of the communities which they form; peculiarities of house architecture; methods of hunting, fishing and carrying on agriculture; character and importance of manufactures; practices relative to war and the taking of heads of enemies; arms used in warfare; music and dancing, and marriage and burial customs; but not constituting a political unit subject to the control of any single individual nor necessarily speaking the same dialect.

Where different dialects prevail among the members of a single tribe it should be subdivided into dialect groups. The differences in language between the people of different dialect groups of a tribe are of course far less radical than are those between the people of different tribes.

Returning now to a consideration of the list of tribes published by Blumentritt and by the Jesuits, I will endeavor by a concrete example to show the absurdity of the conclusions to which one is led who follows their classification.

Blumentritt assigns the following fifteen tribes to Nueva Vizcaya: *Alimut, Altasanes, Bunganganes, Ibilaos, Ifugaos, Ifumangies, Ilamut, Ileabanes, Ilongotes, Isinays, Italones, Mayoyaos, Panuipuyes, Quianganes,* and *Silipanes.*

The Jesuits add the *Igorots* and the *Irayas.*

Nueva Vizcaya has been so thoroughly explored that no unknown tribe can possibly exist there, and these explorations have shown conclusively

that there are but three non-Christian peoples in the province, *viz*: the *Ilongots*, the *Ifugaos*, and the *Isinays*. Of the remaining tribal designations employed by Blumentritt, *Ibilaos* and *Italones* are synonyms of *Ilongots*; *Alimut* and *Ilamut* are synonyms; and the *Bunganantes* or *Bunnayanes*, *Mayoyaos*, *Quianganes*, and *Silipanes* are all *Ifugaos* to whom the names of their *rancherias* (or in the case of the *Alimut*, the name of their river valley) have been applied as tribal designations.

The *Altasanes*, *Ifumangies*, *Ileabanes*, and *Panuipuyes* do not exist. In all probability these latter names were taken from those of *rancherias* which have long since disappeared. While some of the larger *rancherias* in northern Luzon are very old, others are of recent origin and the names and locations of these settlements are constantly changing.

When descending the Saltan River valley in 1905 I was greatly puzzled by my failure to find numerous *rancherias* shown on the Spanish map which I was using. As the Spaniards had a garrison at Balbalasan, it seemed that they should certainly have mapped correctly the *rancherias* on the upper Saltan River. I inquired concerning the ones which seemed to be missing and learned that the people of one had been decimated by smallpox and the survivors had burned the houses and fled; those of another had practically been exterminated by their enemies; those of a third had moved in search of more extensive agricultural lands, and so on. Meanwhile several new *rancherias* had sprung up. Therefore, it will readily be understood how it is that in many instances no peoples can at present be found answering to names which a few years ago were considered to be tribal designations.

To the lists of tribal names employed by Blumentritt and the Jesuits which may be excluded from further consideration because no people can at present be found who apply these names to themselves must be added the *Addang*, *Adanglas*, *Aripas*, *Bayobanan*, *Bujuanos*, *Gamungan*, *Ilelapanes*, *Jumangi*, *Nabayuganes*, and *Pungianes*.

As already stated, the term "Buries" of the Jesuit list is not a tribal designation at all, while the separation of the Negritos into *Abunlon*, *Aetas*, *Adanglas*, *Atlas*, *Balugas*, *Buquiles*, and *Dumagas* is hardly justified. It is true that the groups of *Negritos* to which these names have been applied differ more or less, these differences depending on the extent to which they have intermarried with neighboring peoples; and since they have always adopted the languages of their civilized neighbors they often speak different dialects as well; but they have all attained to substantially the same degree of civilization, or perhaps better, they all continue to lack civilization to substantially the same degree and can not be considered as belonging to different tribes when the word "tribe" is employed in the sense in which I use it in this article.

I will not here further criticize the lists of Blumentritt and the Jesuits,

but will state that in my opinion the following tribes should be recognized in northern Luzon:

I The Negritos. II The Ilongots (Ibilaos). III The Kalingas. IV The Ifugaos. V The Bontoc Igorots. VI The Lepanto-Benguet Igorots. VII The Tinguians.

A word as to terminology. Dr. Barrows and Dr. Jenks in writing the names of Philippine tribes have ordinarily used the same form for both singular and plural, although Dr. Barrows at least has been very inconsistent in this matter. This usage has been allowed under protest in printing his contributions to the Census Reports.[4] There is some excuse for it when the name of a tribe is of Malay origin, but it becomes absurd when applied to names derived from the Spanish, as, for instance, *Negrito*. When one is writing English rather than Malay it seems to me well to form plurals in the usual way by adding "s" or "es" to the singular, and I have followed that usage in this article.

I will now endeavor to describe briefly the several tribes above listed, giving under each—

1. The synonyms of its name as well as the names of peoples which now exist or are supposed to have existed and have been given separate tribal rank, and in my opinion are not entitled to such rank, but should be classed as belonging to the tribe under discussion.

2. Its habitat so far as it is at present known.

3. A brief description of the physical characteristics of its members; of their dress and ornaments, including ornamentation of the skin by scarring or tattooing; of their buildings and settlements; of their hunting, fishing, agriculture and manufactures; of their methods of warfare and head-hunting; of their arms; of their music and dancing; of their marriage customs, and of their customs relative to the burial of the dead.

I shall not discuss folklore, or religious beliefs, or other ceremonials except in so far as they are directly related to the subjects above mentioned.

Tribe I. THE NEGRITOS.

SYNONYMY.

ABUNLON. Name applied to the *Negritos* of Zambales, especially when of mixed blood.

ABURLIN. Name applied to the *Negritos* of Moriones, Tarlac.

ADANG. Name of a *Negrito* people which formerly inhabited Mt. Adang in North Ilokos at the extreme northern end of the Cordillera Central. No such people now exists.

ADANES. Synonym of *Adang*.

ADANGINOS. Synonym of *Adang*.

ADANGTAS. Synonym of *Adang*.

ADAUGTAS. Synonym of *Adang*.

[4] *Census of the Philippine Islands of 1903* (1905). 1, 453.

AETAS. The common name for *Negritos*. It has been applied more especially to those of Cagayan, Isabela, Pampanga, Bulacan, and Bataan.

AGTAS. Name applied to the *Negritos* of Isabela.

AHETAS. Synonym of *Aetas*.

AITAS. Synonym of *Aetas*.

ATTAS. Name applied to the *Negritos* of Cagayan.

BALUGAS. Name applied to the *Negritos* of Nueva Ecija, Pampanga, Zambales, Ilocos Sur, and Tarlac; especially to those of mixed blood.

BUQUILES. Name applied to the *Negritos* of Zambales.

DUMAGAT. Name applied to those of the Pacific coast of northern Luzon.

DUMAGAS. Synonym of *Dumagat*.

DUMANGAS. Synonym of *Dumagat*.

ETA. Synonym of *Aetas*.

ITAS. Synonym of *Aetas*.

PARAMES. Name applied to the *Negrito* inhabitants of a *rancheria* in the municipality of Baggao, Cagayan.

HABITAT.

The *Negritos* are still numerous in the mountains of Bataan and Zambales and in the eastern mountain chain of northern Luzon extending from Cape Engaño to Baler. They are found in limited numbers in the mountains of Rizal, Bulacan, Pampanga, Tarlac, Pangasinan, and Ilokos Norte. A few still remain in Nueva Ecija and Abra.

There is a considerable area between the Rio Grande de Cagayan and the Ablug River in the Province of Cagayan which is populated almost exclusively by *Negritos*. They are also to be found in the former *comandancias* of Infanta and Principe, which now constitute part of the Province of Tayabas.

DESCRIPTION.

The Negritos, generally believed to have been the aborigines of the Philippines Islands, are racially distinct from the other tribes.

It is possible that when they have been more carefully studied we shall find it is necessary to subdivide them into several tribes. At present, next to nothing is known of those inhabiting the great eastern Cordillera of northern Luzon, from the latitude of Baler to Cape Engaño. However, the inhabitants of the remaining *Negrito* settlements in northern Luzon are quite well known and are in every way so similar to each other that there seems to be no sufficient reason for making any attempt to subdivide them.

The *Negritos*, as is well known, are as a rule of dwarfish stature, but contrary to the usual belief, many of them are well formed.

Among 77 Zambales *Negritos* selected at random and measured by Mr. Reed, the tallest man measured 5 feet 2 inches, and the tallest woman 4 feet 11 inches. The average height of 48 men was 4 feet 9 inches; that of 29 women was 4 feet 6 inches. The shortest man measured was 4 feet 2 inches high, and the shortest woman 4 feet.

The photographs of an adult man and woman standing beside me, which are reproduced in Plate I, figs. 1 and 2, give a good idea of relative

size. The types shown are full-blooded *Negritos* of Bataan. Unfortunately, many of the persons measured by Mr. Reed were of mixed descent and some were even half-breeds.

The *Negritos* are of a dark, sooty-brown color and have woolly hair, which is usually black but may be reddish-brown. The men often have abundant beards and a thick growth of hair on the arms, chest, and legs. (Pl. IV, figs. 1 and 2.) They have broad and flattened noses, thick lips, long arms, and in many instances prominent abdomens. They make no attempt to dress their woolly hair, which stands out from their heads and is allowed to grow until it gets long enough to be troublesome, when it is chopped off with a bolo, or cut with scissors if they are fortunate enough to possess any. (Pl. II, fig. 1.) Some of the Bataan *Negritos* shave a round spot on the crown of the head during the hot months of the year. (Pl. IX, fig. 1.) This, they say, is to let the heat out! Those of Zambales occasionally shave the entire back of the head up to a line extending from one ear to the other, over the top of the cranium. (Pl. XIV, fig. 3.)

The custom of pointing the front teeth is widespread among the representatives of this tribe. The operation is performed not with a file, as is commonly supposed, but in the following manner: A chip of wood is placed back of the tooth to be operated on, the point of a bolo is pressed firmly against the front surface of the tooth and the bolo is struck a sharp blow with a stick or stone, so that a corner of the tooth is chipped off. This operation is repeated on the other side and an artistic point is thus produced. (Pl. XXI, fig. 4.)

The Negritos do not tattoo themselves, but do ornament themselves with scar-patterns, produced by making cuts through the skin with slivers of bamboo. (Pl. XXIII, fig. 1.) Into these cuts, which are arranged with more or less geometric symmetry, dirt is rubbed to cause them to become infected and to produce large scars. The men may have scar-patterns on their chests, backs, and arms; the women on their chests, backs, arms, the calves of their legs, fronts of their thighs (Pl. XXV, fig. 1), and sometimes also on their breasts and abdomens.

The normal dress of the *Negrito* men and boys is a clout of bark or cloth (Pl. I, fig. 1; Pl. II, fig. 1); that of the women is a short skirt of bark or cloth, reaching from the waist to the knees (Pl. I, fig. 1; Pl. XII, fig. 1). However, as many of the groups of *Negritos* frequently come in contact with civilized natives, they often acquire from the latter articles of civilized dress of which they are very proud. Many of the women habitually wear *camisas* or upper garments, which the ones who are unmarried are very reluctant to remove.

Their ornaments are varied and characteristic. The most peculiar ones are bamboo combs, which the women wear thrust into their back hair; these are decorated with scratch-work patterns, which are blackened by rubbing grease and soot into them. In many instances they are

provided with depending plumes of horsehair, to which bright-scarlet, yellow and white feathers are fastened with bits of beeswax; these plumes are attached to the concave, or inner, surfaces of the combs by means of the same material. (Pl. XXV, fig. 4.) A highly characteristic *Negrito* ornament consists of circlets of boars' bristles, worn by the men about the calves of the legs. (Pl. X, fig. 1.)

Their other ornaments are earrings, bits of copper wire, buttons, beads, pieces of looking glass, and similar things. Many have no ornaments of any sort. Like most of the other non-Christian peoples in northern Luzon, they are especially fond of bright-scarlet cloth.

They often employ "medicines," consisting of leaves or herbs which are pasted on their temples or thrust through the holes in their ears, and of tubers or seeds which are strung on bits of creeper or rattan and hung about their necks. (Pl. XXIII, fig. 1.) These remedies are supposed to be of value in curing colds, headaches and fevers.

They have practically no manufactures of their own. On occasion they roll leaf tobacco into rude cigars for their personal use. They fashion their bows and wooden-headed arrows and lances with bolos obtained from the Christian natives. The arrow and lance-heads of iron and steel which they sometimes possess are all obtained by purchase or trade. They make no cloth or pottery and, so far as my observation goes, do not even know how to make any fermented drink, although they are at no loss to know the use to which such drink is commonly put and when supplied with it by others promptly get intoxicated.

Most of the Negritos, while somewhat inclined to be mischievous and thievish, are timid and peaceful. They have feuds among themselves, but seldom make war on neighboring tribes. However, the people of some of the settlements in the eastern cordillera of northern Luzon have the reputation of being quite fierce and warlike. The bow and poisoned arrow are the principal weapons used in war. (Pl. X, fig. 1.) The *Negritos* are afraid of strangers and sometimes take "pot shots" from ambush at persons who invade their territory without giving due warning of their approach. Head-hunting is unknown among them.

Normally the *Negritos* are nomadic in their habits, and as a natural result they do not build houses worthy of the name. Their dwellings are mere huts with roofs of leaves or grass, under which there may or may not be sleeping platforms of poles. (Pl. XXIX, fig. 2.) Such huts can be constructed in a few moments and are of course abandoned without regret. They are usually scattered here and there through the forest, although occasionally a group of one or two dozen will be found together. Governor Blas Villamor informs me that the largest settlements of northeastern Luzon number forty to fifty families.

The *Negritos* subsist chiefly on game, fish, wild honey, and forest products. In fishing they sometimes use small traps and sometimes bows and arrows. I have found those of southern Isabela very skillful in

the use of circular casting-nets, which they occasionally obtain from their civilized neighbors. In hunting they employ dogs, and often, also, nets into which deer and wild hogs are driven in order that they may be lanced while entangled. They are very skillful in the use of the bow and arrow and in their hunting employ poisoned arrows which bring large game down very quickly, without rendering the flesh unfit for eating. Snakes, lizards, frogs, and certain insects and insect larvæ are prized by them as articles of food.

Most of the *Negritos* do not practice agriculture at all. A few of the individuals who have come in contact with the civilized natives, plant *camotes* (yams) and squashes, and a still smaller number a limited amount of mountain rice. Little or no cultivation is given to the crops when planted, and it often happens that by harvest time their owners have wandered off through the mountains to some point many miles distant, thus losing the fruits of their labor.

In very rare instances small groups of *Negritos* settle in some particular locality and actually cultivate fields. In such cases they usually build houses which, while but feeble imitations of those of their civilized neighbors, are a distinct improvement over their ordinary huts.

Dogs and chickens are their only domestic animals, and they have few of the latter.

They are very found of music, although their instruments are of a primitive sort. They make "jew's-harps" and flutes from bamboo, but their principal musical instrument is the copper timbrel imported from China and known throughout northern Luzon as the *gansa*. (Pl. LII, fig. 4.) Bamboo violins and rude guitars are sometimes seen among them, but dance music is almost always furnished by *gansas* alone. I have seen men dancing on their knees and playing *gansas* at the same time. (Pl. LII, fig. 4.) The most characteristic *Negrito* dance is the so-called circle dance, in which men, women, and boys group themselves about one or two of the older inhabitants of the settlement; each person hooks two or three fingers into the clout or waistband of the skirt of the individual in front of him and the whole company then begins slowly to move in a circle with much stamping of feet and some shouting and singing, the latter being usually performed with the mouth covered by the hand. This circle dance, which is indulged in at funeral and wedding feasts and on other important occasions, is often kept up until a dusty path has been worn through the sod. (Pl. LII, figs. 1 and 2.)

Various obscene dances of the *Negritos* have been described by travelers. Many of these tales are obviously untrue, as are all stories to the effect that these people go wandering through the forest in a state of absolute nudity; but Dr. Thos. R. Marshall, formerly Chief Health Inspector of the Philippine Islands, has described to me in detail an obscene dance participated in by one woman and two men which he witnessed at night in the mountains of Zambales. His word is above suspicion. I have

neither seen nor heard of similar dances among any of the other northern Luzon tribes.

Mr. Reed describes the following special dances which he observed among the *Negritos* of Zambales:

The *camote* dance, in which the performer, after some preliminary fancy steps, goes through the motions of finding a *camote* patch, digging the tubers, putting them in a sack, and shouldering it, all the time keeping watch for the owner in order that he may not be caught stealing. He then cuts his way through the fence which surrounds the patch, attempts to ford a river, gets into deep water, and loses his burden. The feet are kept in rapid motion throughout this pantomime and the body is bent forward in a crouching position, so that great physical exertion is involved.

In the bee dance, the performer finds a nest of bees, which is conventionally represented by a piece of cloth tied to a pole. He then goes through the motions of making a smudge, climbing the tree, and holding the smudge under the nest. He is stung, retreats, makes other attempts and finally succeeds in smoking out the bees and securing the honey, whereupon he holds a feast.

In the torture dance, a person who represents the captive is bound to a stake and the participants first execute a circle dance, with its usual vocal accompaniments, around him. The movement soon becomes very rapid, until the performers are leaping around in an apparent state of great excitement. Finally, when worked up to a proper point they draw their bolos, rush at the victim, and go through the motions of chopping him to pieces.

In the lovers' dance, a man and a woman take part. The woman keeps her feet moving in time to the music but remains in one place. The man dances about her with various extravagant gestures, and the performance is continued until both are tired out.

In the duel dance two men, armed with bows and arrows, have an imaginary encounter. One of them ultimately succeeds in placing a fatal shot, his opponent falls to the ground, the victor dances up to the body and goes through the motions of cutting off the head with a bolo. He then calls for the relatives of the dead man to come and avenge the deed, but as no one appears he buries the head and body. Mr. Reed states that this dance lasts some fifteen minutes and that during this time the man, who by previous arrangement was to be the victor, never for a single instant pauses or loses step.

In practice the *Negritos* are ordinarily monogamous, but polygamy is allowed and is not infrequently indulged in, inability to support more than one wife being apparently the usual reason for not having a larger number.

Among the *Negritos* of Zambales and Bataan, when a young man has found a girl whom he wishes to marry, he informs his parents, whereupon the family discuss her value, and after an agreement has been

reached on this point the suitor or some one of his relatives goes to her parents to ask if the suit will be favorably considered. If an affirmative answer is received they return and a little later take presents to the father of the prospective bride. If he is satisfied, he gives his consent. If not, more presents must be forthcoming. Betrothals are made by parents for children of very tender years, but actual marriage does not take place until about the age of puberty.

The marriage ceremony varies in Zambales from practically none at all in the Pinatubo region to a rather complicated affair in the vicinity of Olongapo. In some cases, as soon as payment has been made for the bride, a dance follows, after which the young couple go to their own hut. In other *rancherias* there is a ceremony during which food is exchanged. A mat is placed on the ground and on it is set a dish of cooked rice. The bride and bridegroom seat themselves, facing each other, with the dish between them. The man places food in the mouth of the woman and she reciprocates, whereupon the crowd set up a shout and the ceremony is held to be terminated. Sometimes the girl runs away and her husband pursues her, calling to her to stop, and she ultimately does so.

I once witnessed a marriage ceremony among the *Negritos* inhabiting Mount Mariveles, in Bataan Province. The bride and her friends hid in the forest. The bridegroom and his friends searched until they found them. The bridegroom then attempted to persuade the bride to go to the place where the ceremony was to be concluded, beating a *gansa,* dancing in front of her, and constantly retiring in the desired direction. The bride had a piece of cloth which she kept drawn over her head and face and she moved along the ground a few yards at a time in a squatting position. When the sweet music discoursed by the bridegroom failed to accelerate her progress sufficiently, he or his friends placed gifts a short distance in front of her. Ultimately she came out into a clearing in which a platform had been erected some 12 feet above the ground. An inclined plane of poles led up to this platform. The relatives of the bride gathered about her, armed with long rattans. The bridegroom made a rush for her, getting soundly whacked in the process. He seized her in his arms, and carried her up to the top of the platform, where both of them sat down with their arms interlocked. Some of their friends and relatives also mounted the platform. Others placed gifts at the bottom of the inclined plane to persuade the couple to come down. Ultimately they descended and squatted in front of an old man and an old woman who had been detailed to give them "good advice."

Mr. Reed states that divorce is not common among the *Negritos* of Zambales and that there seems to be a prejudice against it. My observation is that it is quite common among the *Negritos* of Bataan. It is effected by mutual consent between the two persons interested, if their respective families agree to the arrangement. Where there has been no

fault on the part of either person the property is divided equally, but the mother takes the children.

If a woman deserts her husband for some other man whom she prefers, the new husband must pay a fine, and if he can not be compelled to do so the family of the woman must pay back to the husband what he gave for her. If the new husband is caught, and is unwilling or unable to pay the fine imposed, he may be put to death.

The dead of the Bataan *Negritos* are buried in the ground at some distance from the houses, after more or less elaborate ceremonies. The graves are often fenced in to keep wild hogs away. The relatives of the deceased watch the graves for some time and hold occasional feasts near them.

The Zambales *Negritos* also bury their dead in the ground, wrapping them in mats and placing them in graves 3 or 4 feet deep.

Unfortunately, there is little reason to believe that the *Negritos* can ever be civilized. Attempts in this direction heretofore made in the cases of individuals have usually ended in lamentable failure. Even children who have been taken very young and brought up in christian families have shown a strong tendency to return to a wild life.

Negritos have in many places been greatly imposed upon by the christian natives, and in not a few cases their children have been stolen from them by the latter, nominally so that they might be christianized but really in order that they might be brought up as slaves. Their parents have revenged themselves on their civilized neighbors by raiding crops and killing or running off cattle.

Under strong provocation they are entirely capable of doing murder, but murderous attacks are usually the result of gross mistreatment.

For the present, at any rate, all that can be done for these little blacks is to protect them from their civilized neighbors and persuade them to refrain from making trouble when they are not themselves molested.

They are a fast disappearing people, but their numbers do not seem to be diminishing as rapidly in northern Luzon as in other parts of the Archipelago. The total number of *Negritos* in the Islands is commonly estimated at 25,000, but while the whole northeastern coast line and the Pacific cordillera of northern Luzon remain unexplored, and while we do not even know whether true *Negritos* exist in the interior of Mindoro, such an estimate is at the best but a mere guess.

Tribe II. THE ILONGOTS.

SYNONOMY.

IBILAOS. Name applied to the *Ilongots* by the *Isinay* people of southern Nueva Vizcaya.

ILUNGUT. Synonym of *Ilongots*. Name applied by the *Ilongots* of Tayabas to themselves.

ITALONES. The *Gaddan* name for the *Ilongots*.

LINGOTES. Synonym of *Ilongots*.

HABITAT.

Southeastern and southern Isabela, especially along the head waters of the Rio Grande de Cagayan; eastern Nueva Vizcaya; mountains along border between Nueva Ecija and the old *comandancia* of Principe, now a part of the Province of Tayabas; also the old *comandancia* of Infanta, now a part of the same province. There are a few, small, isolated *rancherias* near Dupax, in Nueva Vizcaya.

DESCRIPTION.

The *Ilongots* are of Malay origin, showing, however, abundant indications of a considerable infusion of *Negrito* blood. In southern Isabela, where they are in close contact with the *Negritos*, they still intermarry freely with the people of the latter tribe. As a result, many of them are dark-skinned, curly haired, abundantly bearded and of low stature. (Pl. IV, fig. 3.) Some of them, however, seem to be nearly pure Malays, and an occasional individual may be met with who has quite sharp and regular features. (Pl. IV, fig. 4.) The hair, which the men as well as the women allow to grow long, is confined in a knot at the back of the head, around which strips of bark or cloth are sometimes wrapped. Many of the men wear over the hair and just above the forehead in front, a net which, while keeping the hair out of their eyes, also serves as an ornament. (Pl. IX, fig. 2.) No other Philippine tribe uses a hair-net of this sort.

The dress of the men consists of the usual clout and that of the women of a skirt reaching from the waist to the knees. (Pl. II, fig. 2: Pl. XII, fig. 2.) These garments are sometimes, though rarely, supplemented by shirts in the case of the men and by *camisas* with the women, but the latter articles, even if possessed, are worn only on state occasions.

The ornaments of the *Ilongots* are peculiar to, and highly characteristic of, this tribe. I have referred to the curious hair-nets worn by the men. Another common and peculiar ornament is a girdle made of small cowries strung on bits of cloth or twine. The women and sometimes also the men wear girdles of this type about the waist, or extending over one shoulder and under the opposite arm. (Pl. XX, fig. 1; Pl. II, fig. 2.) As the *Ilongots* are essentially an inland tribe, extending to the coast only in Principe and Infanta, it is remarkable that these shell girdles should be so generally distributed. They are highly prized, and must be secured with difficulty. Another very characteristic ornament consists of a round and concave piece of mother-of-pearl on which black scratch-patterns have been made. (Pl. XXV, fig. 5, *a* and *b*.) This is attached by means of a bit of wire to the ear, usually to the cartilage of its upper border. (Pl. VII, fig. 3.)

Still another highly characteristic ornament is an hour-glass shaped affair made of copper wire, coiled spirally. It is worn by the women, usually on the left arm but occasionally on the right, and extends from the hand to the elbow. It is so heavy as seriously to interfere with the use of the arm on which it is worn. (Pl. XX, fig. 1.)

The *Ilongots* like to wear about the neck, the waist, or over one shoulder and under the opposite arm, great coils of fine copper wire or of a fine cord, the latter woven in ornamental patterns from strips of bark or fiber stained in different colors. They are also very fond of wearing coils of split rattan of a scarlet color, which they say is the natural one. (Pl. VII, fig. 3.) They have other ornaments, consisting of tufts of bristles or tassels of fine thread, to which, with infinite pains, they attach bright bits of metal, feathers, etc. (Pl. XXV, fig. 5, *b*.) Many of the bristles are ringed about with fine threads of bright colors. Tobacco pouches of bark cloth are decorated with ornamental stitch-patterns of colored thread and with bright-colored seeds. Lime-boxes of bamboo are sometimes ornamented with scratch-patterns, darkened after the Negrito fashion with grease and soot. Elaborate armlets of polished bands of metal of different colors are commonly worn by the men.

In short, the *Ilongots* display a high appreciation of ornaments, and with the very limited means at their disposal show much patience and ingenuity in fashioning them.

I have never observed *Ilongots* who were tattooed to any extent, but Governor Villamor informs me that he has seen men whose chests were covered with tattoo marks. They do not ornament themselves with scar-patterns, as do the *Negritos*.

Some of their houses are fairly well constructed and of considerable size. (Pl. XXX, fig. 2.) They are built on piles set firmly in the ground, or on the trunks of trees which have been cut off at a considerable distance above its level. To enter a house one must usually scramble up an inclined pole, which may or may not have notches cut in it. The house often has an outside platform. The floor is made of bamboo or of the smooth stems of saplings tied in place with rattan or creepers. The sides may be low and open, or high and covered with palm or rattan leaves or with grass. The roof is well thatched and has a good slope; it ends in a short ridge from each end of which there projects a pointed piece of wood, curving upward with a broad sweep. This form of roof and type of roof ornament are peculiar to the *Ilongots*. Not all of the houses have the pair of sticks projecting from the ridge of the roof like a pair of horns, but most of the better ones are so decorated. While some of the houses are wretched affairs (Pl. XXX, fig. 1), all, so far as my observation goes, are better than *Negrito* huts.

In addition to their houses, the *Ilongots* make small, but well-constructed, rice granaries, on the roofs of which often may be seen the same curved and pointed pieces of wood which appear on those of their dwellings.

These people often live together in considerable numbers. Their houses are usually scattered irregularly about clearings made by girdling forest trees and cutting and burning underbrush.

They keep dogs for use in the chase. Occasionally, also, they have pigs

and chickens, but I have never seen any other domestic animals about their settlements.

The manufactures of the *Ilongots* show a distinct advance over those of the *Negritos*. They do not weave cloth, but make the so-called bark cloth and also circular casting fish-nets, buying the necessary cord and sinkers from the Christian natives. The women sew with a reasonable degree of skill and embroider as well, in a rude fashion. The men make head-knives, metal lance-heads and arrow-points, employing in their blacksmith operations the usual double-barreled bellows and a charcoal fire. They also manufacture many of their own ornaments, as well as their wooden shields, and construct small wooden boats which they handle quite skillfully in swift water. They grow, cure, and roll their own tobacco.

They prepare *basi*, extracting the juice of the sugar-cane with a simple mill similar to that used by the *Kalingas*. (Pl. XL, fig. 2.) The juice is then boiled for a short time and is put into *ollas* and kept. No spices or fruits are mixed with it at any stage, and after fermentation it becomes clear and ultimately quite sour.

The *Ilongots* are more warlike than are the *Negritos*, but are cowardly, their attacks being almost invariably made from ambush. Feuds exist to some extent between their different settlements, as well as between *Ilongots* and *Negritos*. Christian natives who are forced to travel the lonely mountain trails of their country are sometimes attacked and killed by them, robbery being, it is said, the usual motive of the aggressors. Occasionally, also, the *Ilongots* attack barrios of the civilized towns and take a few heads to assure a good rice-crop for the coming year, or to avenge wrongs received at the hands of the Christians.[4]

Like the *Negritos*, the *Ilongots* depend largely on fishing and the chase for their food supply. In taking game, they employ nets of their own manufacture and use bows and metal-headed arrows and lances. Their hunting arrows and lances are usually made with detachable heads fastened to the shafts with strong cords. (Pl. XV, figs. 3 and 4.) When the barbed head of such an arrow or lance is fixed in an animal, the shaft, dropping loose and catching in the brush or grass, impedes the escape of the game.

The *Ilongots* are expert fishermen. They are very successful in the use of circular casting-nets and are also skilled in spearing fish by torchlight.

Their agriculture, while a distinct advance over that of the *Negritos*, is primitive. They select a suitable piece of forest land, girdle the trees, and chop down the brush. (Pl. XXXVII, fig. 1.) When the trees have

[4] Dr. M. L. Miller informs me that when *Ilongots* murder travelers on the trail from Nueva Ecija to Baler, in Tayabas, they never rob their victims, even though the latter may be loaded with goods, but content themselves with cutting off and carrying away a hand or some similar trophy.

died, the brush is burned and in the soil thus left bare are planted mountain rice, squashes, gourds, cucumbers, and sometimes a few tomatoes and a little sugar cane or egg-plant; bananas also are grown abundantly. In planting rice, the women make holes in the ground with specially shaped and carved implements of hardwood, while the men drop in the seed and cover it. (Pl. XXXIX, fig. 1.) The clearings are often quite extensive, although but little care is given to the growing crops, which become buried in a tangle of vines and weeds. However, rice, which is an especially valuable crop, is sometimes quite carefully weeded. It is harvested by cutting off the individual heads, which are tied in bundles, placed on low platfroms, and protected from rain by thatches of leaves. (Pl. XXXVI, fig. 1.) It is said that the *Ilongots* of any given settlement are unwilling to transfer their rice to their granaries until some one of their number has taken a human head in order to assure a good crop for the coming year.

Their arms consist of bows and arrows, broad-bladed head-knives, and lances with weak shafts and still weaker points which are hardly larger than good sized arrow-heads. (Pl. X, fig. 2; Pl. XV, figs. 3 and 4; Pl. LX, fig. 2, *a*.) The shafts of their lances are ornamented with spiral bands of metal or of vegetable fiber for about half of their length. The shields are long and narrow, of very light wood, and are obviously designed for stopping arrows. (Pl. LXI, figs. 1, *a* and 2, *a*.)

The head-hunting of the *Ilongots* is of a rudimentary sort and may perhaps fairly be considered as representing the first step in the evolution of this particular form of sport. They usually cut off the heads of their victims, but either leave them beside the bodies or throw them away after having carried them for a time through the forest. They apparently do not take them home to exhibit at a subsequent ceremony, as do most of the head-hunting tribes. In taking heads the *Ilongots* use a sharp, broad-bladed knife. (Pl. LX, fig. 1, *a*.)

Their most common musical instrument is made of a joint of bamboo, from the outer layer of which strings have been cut, and raised by means of wooden bridges. (Pl. LIX, fig. 1, *a*.) A man holds the instrument, while a woman plays it by striking these strings with two slender, curved strips of bamboo. (Pl. LIII, fig. 1.) In addition to this peculiar instrument the *Ilongots* make and use the nose-flute and the bamboo mouth-organ.

The only dance I have seen was to the accompaniment of the bamboo instrument just described. There was but one dancer, a man, who gave a grotesque and exaggerated imitation of the movements of ambushing and slaying an enemy and taking his head. (Pl. LIII, fig. 2.)

In another one described by Governor Villamor, two or three men and an equal number of women take part. The men form a line and with outstretched arms dance around in a circle. The women never enter the

line, but dance at one side of it. The mouth-organ as well as the bamboo instrument above described are used to provide the music.

The *Ilongots* are polygamous. One man may have several wives who not infrequently all live together in one house. However, if he is wealthy, he may construct as many houses as he has wives, the dwellings being built close together. Many men also secretly keep *queridas* or mistresses, but if this fact becomes known they are obliged to pay fines to the relatives of their lawful wives, and this act also makes lawful wives of their *queridas*.

The *Ilongots* not infrequently abandon their sick. They are said not to use medicines for ordinary illnesses, but only in the treatment of wounds and in connection with childbirth. They try to cure their sick by stuffing them with food.

When a death occurs, the members of the family mourn throughout the ensuing night, keeping up a series of doleful cries which may be heard at a great distance. Early the following morning they desert the house in which the death occurred, leaving it not to return, but they take with them all articles of value. The dead person has the dwelling as his sepulchre. Sometimes, when the house of a sick person is large and valuable and it is evident that he is likely to die, in order to avoid abandoning the more pretentious structure a smaller one is hastily constructed and the patient is removed to it before death occurs.

The *Ilongots* punish robbery among themselves—that is, among the people of a single *rancheria*—by obliging the thief to grasp a piece of red-hot iron. However, if a man from one *rancheria* steals from an individual belonging to another, he is held to have committed a praiseworthy act. A murder among the people of a *rancheria* leads to a feud between the two families concerned. When a person from one settlement kills a person belonging to another, war between the two *rancherias* results. Adultery is punishable by fine paid by the offending person to the family of the one offended.

The *anito* images of the *Ilongots* [a] are made of grass or leaves and are usually set up on river banks. After the necessary measures to propitiate them have been taken they are abandoned or even burned.

In general it must be said of the *Ilongots* that, while superior to the *Negritos*, they are of inferior intelligence and of a somewhat unreliable and treacherous disposition, which makes them far more dangerous than

[a] The word *anito* is used by the *Ibilaos*, the *Kalingas*, the *Ifugaos*, the Bontoc *Igorots*, the Benguet-Lepanto *Igorots*, and the *Tingians*. Primarily it seems to mean a spirit, and in very many cases the term is employed to designate the spirits of the dead. It is also applied to images of men and women carved from wood or made by tying leaves or grass together which have to do in one way or another with efforts to secure the assistance of good spirits and to propitiate evil ones. Gifts are made either to the visible images of *anitos* or to the invisible spirits bearing the same name and various propitiatory ceremonies are performed, the performance of such ceremonies being termed by some tribes "making *anito*."

their little black neighbors. They keep very much to themselves, maintaining only such intercourse with the people of the neighboring civilized communities as may be necessary in order to secure salt, metal, cloth, and a few other necessaries. However, the experience of Americans with them has tended to show that they appreciate fair dealing and that when their confidence has been won they refrain from hostile acts toward those who have become the objects of it.

Probably, as in the case of the *Negritos*, there is little hope of doing more for them than to protect them from the aggression of the civilized natives and to cause them to refrain from hostile attacks upon others.

They constitute a sharply marked tribe, the members of which may usually be distinguished without difficulty from any of their non-Christian neighbors.

The names *Ilongots*, *Ibilaos*, and *Italones* are designations for the same people, and I have adopted the former because it seems to be the one in more general use.

Tribe III. THE KALINGAS.

SYNONYMY.

ARIPANES. Synonym of *Aripas*.

ARIPAS. Name applied to the *Kalingas* who formerly lived near Tubang, Cagayan. No such people now exists.

BAYABONAN (?). Said to have been a tribe occupying the "mountains east of Tuao, Cagayan." As the country east of Tuao, Cagayan, is a level plain, it may well be doubted whether such a people ever existed. At all events they do not now exist.

CALAGUAS. Synonym of *Calauas*.

CALAUAS. Name applied to the *Kalingas* occupying the heights in the neighborhood of Malaueg and the valley of the Rio Chico, in Cagayan.

CALINGAS. Synonym of *Kalingas*.

CATALANGANES. Name applied to the *Kalingas* living east of Ilagan, on the Catalangan River, in Isabela.

CATALANGES. Synonym of *Catalanganes*.

CATATANGANES. Synonym of *Catalanganes*.

DADAYAGS. Name applied to the *Kalingas* living west of Cabagan Nuevo and in the lower Saltan River valley.

DADAYAS. Synonym of *Dadayags*.

GADDANES. Name applied to the *Kalingas* of western Isabela Province, many of whom were long since converted to Christianity and have become civilized.

GAMUNGAN. A name which has been applied to the uncivilized inhabitants of the mountains "east and northeast of Tuao, in Cagayan." As no such mountains exist, it is doubtful if there ever was such a people.

GAMUNANG. Synonym of *Gamungan*.

GAMUNANGANES. Synonym of *Gamungan*.

IRAYAS. Name applied by Blumentritt to the people living to the westward of the *Catalanganes*.

KALIBUGAN. Name applied to certain *Kalingas* of Isabela Province.

NABAYUGANES. Name applied to the *Kalingas* living to the westward of Malaueg, in Cagayan.

YOGADES. Synonym of *Gaddanes*.

HABITAT.

The territory inhabited by the *Kalingas* is, broadly speaking, the eastern slopes, river valleys and foothills of the Cordillera Central from the Saltan River north to Dagara and to the vicinity of the valley of the Ablug River. In some places they extend into the level plains of Isabela and Cagayan. There are several important *rancherias* on the Santa Maria friar estate in the former province and there is one north of Ilagan near the Rio Grande de Cagayan. There are a number of others to the east of Ilagan in the level country and in the foothills of the western slopes of the chain of mountains which borders the Pacific coast.

The line of demarcation between their territory and that of the *Tingians* of Bontoc is a fairly sharp one, although there has been some intermarriage in the settlements along the upper waters of the Saltan River. The Cordillera Central separates the *Kalingas* from the *Tingians* of South and North Ilokos. They are constantly at war with those of Dagara and the Apayaos district. They apparently have not intermarried at all with the *Negritos*, and their territory, except for the isolated *rancherias* near Ilagan and those lying to the eastward of Ilagan, is bounded on the east by that of the Christian municipalities.

DESCRIPTION.

The *Kalingas* are of Malay origin. They are less well-known than is any other northern Luzon tribe except the *Ilongots*. They are a cleanly people, of medium stature and are physically well-developed. The average member of the tribe may be recognized at a glance by his high cheek bones, and especially by his peculiarly shaped eyes, which are set very far apart. (Pl. V, figs. 1 and 2; Pl. IX, fig. 3.) No other Luzon people have such eyes. The skin is brown, the hair black and usually straight, but in some rare instances wavy. The men wear the hair long behind, and banged across the forehead, with a cut extending from the level of the bang along each side of the head over and considerably back of the ear. The long, back hair is allowed to hang down. (Pl. IX, fig. 3.) This method of cutting the hair is peculiar to the people of this tribe, although a very similar style is followed by the Bontoc *Igorots*.

In spite of the remoteness of the regions which they inhabit, the *Kalingas* are better dressed than the people of any other northern Luzon tribe except the *Tingians*. The men wear the usual clouts, but in addition have short jackets, which, like their clouts, are often ornamented with beadwork. Many of them have collars of beads. They also usually wear blankets of silk or very gaily colored cotton cloth, which are knotted over the right shoulder in such a way that the arm on the opposite side is supported in a fold. A bag or sack which is opened and closed by sliding silver or brass rings is often worn around the neck. (Pl. X, fig. 3; Pl. VII, fig. 4.)

Huge holes are pierced in the lobes of the ears and stretched to receive great rolls of gaily colored worsted or cotton yarn, or plugs of wood which extend back along the sides of the neck in such a way as to turn the lobes of the ears forward. When wooden ear-ornaments are used, coins, pieces of brightly colored stone, or bits of looking-glass are inserted

in the ends which are directed forward, or these ends are covered with pieces of cloth embroidered in bright colors. (Pl. VII, fig. 4.)

The women wear skirts reaching from the waist to the knees, or, in rare instances, even to the ankles; also *camisas* of brightly colored and large-figured cloth of European manufacture, or of the handsome striped cloth which they themselves weave. (Pl. XII, fig. 3; Pl. XVII, fig. 2.) They wear clouts under their skirts.

That the habitual wearing of so many clothes by the women is a matter of display rather than of modesty is shown by the fact that they discard their *camisas* when at work, and if they have occasion to cross deep streams, strip naked, regardless of the presence of men.

Nearly every woman or girl owns a pair of huge brass earrings of a peculiar form (Pl. XX, fig. 2) which weigh two to four ounces. The part which passes through the ear is wrapped in leather or cloth to prevent its chafing the flesh. Still more highly prized are large ear ornaments of mother-of-pearl, each shaped like a solid figure 8. (Pl. XX, figs. 3 and 4.) Many heavy necklaces are also worn. (Pl. XX, fig. 3.) The beads most highly prized, called *munding*, are of agate and very roughly made. (Pl. XX, fig. 4.) They are apparently valued on account of their age, and one of them is sometimes worth a carabao. Next to these in value come imitation agate beads of recent manufacture.

Many of the women have beautiful, long hair, which is banged across the forehead and worn in great coils about the head, being held in place by numerous strings of beads. (Pl. XX, fig. 3.) On state occasions it is the fashion to wear great switches of dead hair. (Pl. XX, fig. 4.). Very wealthy women and influential men sometimes wear elaborate ornaments of scarlet and yellow feathers. (Pl. XX, fig. 4; Pl. VIII, fig. 1.)

The *Kalingas* do not tattoo themselves to any very great extent. The women sometimes have marks on the throat or the forearms supposed to bring good luck. (Pl. XXIII, fig. 2.) The men are tattooed even less than the women. Their marks are usually on the shoulders and are said to be of no special significance.

Their settlements consist of groups of from three or four to a score of houses, placed close together and often perched in some inaccessible spot on a steep mountain side. (Pl. XXVII, fig. 1.) Not infrequently they are surrounded by wind-breaks of bamboo. The houses are of two types. Those built on the ground are quite clean and are very substantially constructed. The floors, which are raised five or six feet above the ground, are usually made of well-cleaned stalks of *runo* grass tied close together. The piles on which the houses stand, and their frameworks, are of hard wood. The roofs, which on the inside have a concave curve, consist ordinarily of an inner layer of closely tied and well-cleaned *runo* stems over which is placed a very thick, outer layer of carefully laid grass

common use, I have never seen an individual of this tribe make pottery of any sort. Apparently many of the highly valued earthen pots have come from China.

Wood carving is not common. I have seen only scratch-work, blackened with soot and wax or grease, on bamboo lime-boxes, and ornamental clothes-hangers of carved wood on which figures had been burned with hot irons. *Kalinga* fireplaces are usually provided with carefully cut, stone fire-dogs.

The *Kalinga* is a bold warrior and an inveterate head-hunter. His arms consist of shield, head-axe (Pl. X, fig. 3), and lance. The shield is painted black, with red and yellow rattan lashings. It has three points above and two below and is of a graceful form, peculiar to the people of this tribe. (Pl. LXI, fig. 2, *b*.) The head-axe has a slender blade with a curved, cutting edge on one side and a long, projecting spine on the other. The wooden handle is frequently ornamented with bands of metal of different colors and has on it a projecting point under which the first finger may be hooked to prevent the axe from slipping from the grasp when it is carried blade down. Ordinarily it is thrust into the waistband of the owner. It is a tool as well as a weapon. (Pl. LX. fig. 1, *b*.)

The lances show a great variety of forms. Some of them have heads of hardened bamboo ornamented with scratch-work designs and with plumes of horsehair. Others have steel heads which may be plain or may have two to six or even eight pairs of barbs. Many of the lance-shafts are ornamented with horsehair plumes and with lashings or woven envelopes of scarlet, yellow, and black rattan. (Pl. LX, figs. 2, *b*, *c*, *d*, and *e*.)

The head-hunting expeditions of the *Kalingas* are carefully planned in advance, and a plan of campaign once formed is carried out as closely as circumstances will permit. A band of forty or fifty warriors may be on the trail for days before they reach their objective point. The combat is usually begun from ambush, and is of short duration. The man who first reaches the enemy is the leader. As soon as either side has a combatant down, it concentrates its efforts on saving his head and to this end tries to get away with him as speedily as possible.

Warriors always make a determined effort to secure the heads of enemies killed in battle and to carry them to their *rancherias*, where they are immediately exhibited in bamboo baskets at the houses of the persons who took them. These baskets, which are in general use among the *Kalingas* and *Tingians*, are made in the following manner: A thick piece of green bamboo of the proper length is sharpened at one end and driven into the ground. The other end is split down for a foot and a half or two feet in such a manner as to make a dozen flexible slats. These slats are then separated and others are interwoven with them in a horizontal direction so as to form a conical basket with its point directed downward and ending in a solid stem of bamboo. A pair of partially

and head-hunting customs, their music, their dancing, and especially in the character of their peculiar *cañaos*, at which public events are discussed and victories over enemies are celebrated.

They are strong, cleanly, brave, and intelligent. They are probably less industrious than the *Ifugaos* or Bontoc *Igorots*, but are vastly more so than are the *Negritos* or *Ilongots*. I do not believe that the checking of head-hunting among them will prove to be a matter of any great difficulty, and when they are once on good terms with their Christian neighbors and thus gain a market for their products, they will pay more attention to agriculture.

One former branch of the tribe, the *Gaddanes*, now forms an important element of the civilized population in the Cagayan Valley, and there would seem to be no good reason why the remaining wild *Kalingas* should not follow in their footsteps.

Tribe IV. THE IFUGAOS.

SYNONYMY.

ALAMIT. Name applied to the *Ifugaos* of the Alamit River Valley, Quiangan, Nueva Vizcaya.

ALIMUT. Synonym of *Alamit*.

ALTABANES. Synonym of *Altasanes*.

ALTASANES. Name formerly applied to the *Ifugaos* of northwestern Nueva Vizcaya. No such people now exists.

AYANGAN. Name applied to the *Ifugaos* of the *ranchería* of the same name in Nueva Vizcaya.

BUNGANANES. Said by Blumentritt to be a warlike and possibly head-hunting tribe of Isabela and Nueva Vizcaya. No such tribe now exists.

BUNNAYAN. Name applied to the *Ifugaos* of Quiangan and neighboring *rancherías*.

EPOCAOS. Synonym of *Ifugaos*.

GILIPANES. Synonym of *Silipanes*.

ILABANES. Blumentritt quotes Diaz Arenas as authority for the existence of such a tribe in Nueva Vizcaya in 1848. It no longer exists.

IFUGADOS. Synonym of *Ifugaos*.

IFUMANGIES. According to Diaz Arenas, who is quoted by Blumentritt, a tribe of "*Igorrotes*" of Nueva Vizcaya in 1848. No such people now exists.

ILAMUT. Synonym of *Alamit*.

IPUCAOS. Synonym of *Ifugaos*.

IRAYAS. Name applied by the Jesuits to the *Ifugaos* and *Kalingas* inhabiting the banks of the River Ilaron and the eastern slopes of the Sierra Madre in Nueva Vizcaya, Isabela, and Cagayan.

MAYOYAOS. Name applied to the *Ifugaos* of the *ranchería* of Mayoyao and other neighboring *rancherías* of Nueva Vizcaya.

PANIPUYES. Synonym of *Panuipuyes*.

PANUIPUYES. According to Blumentritt "a tribe of so-called *Igorrotes* to to be sought in western Nueva Vizcaya and Isabela." No such tribe now exists.

PUNGIANES. Classed by Blumentritt interrogatively as "a tribe of the *Mayoyaos*." No such people now exists.

(Pl. II, fig. 4; Pl. XIV, fig. 1): from each a pendant, also of operculа, hangs in front. These girdles are very valuable and, if their wearers are to be believed, are often the property of the settlement rather than of the individual; their use seems to be confined to men of high rank or of great wealth. The women wear armlets or leglets of copper wire, earrings, bead necklaces, and strings of beads in the hair. (Pl. XVII, figs. 3 and 4.) The beads are in some instances very large and of a white stone resembling fine grained marble. (Pl. XXII, fig. 3.) Both men and women occasionally wear in their hair white tail-feathers from cocks. (Pl. V, fig. 4; Pl. XIV, fig. 2.)

The *Ifugaos* live in *rancherias* which sometimes number five or six thousand souls. However, the houses of a given *rancheria* are not placed closely together, but are scattered about in little groups of from four or five to a dozen or two, so that a settlement may extend along a valley for ten miles. Doubtless one of the reasons for this arrangement is that the people desire to be near their wonderful, terraced rice-fields, in order to watch the supply of irrigation water and to prevent depredations upon their crops. (Pl. XXVI; Pl. XXXVII, fig. 2.)

Their dwellings are built from 5 to 8 feet above the ground, on strong piles which are often ornamented with rough carving. (Pl. XXXII, fig. 2.) They have board floors and sides and thatched roofs. In the peak of the roof there often is a small room in which rice and other commodities are stored. At one side of the main living-room is a fireplace made of earth and stones; the smoke escapes through the chinks of the house as best it may. Over the fireplace and at its sides, are grouped the skulls of animals killed in the chase or sacrificed at feasts, and also, on occasion, the skulls of enemies whose heads have been taken in war. Carved, wooden images, called *anitos*, are not infrequently seen at the sides of the door. (Pl. LXIII, fig. 1.) The houses are usually windowless. I have seen lizards carved in relief on the under surfaces of floor boards.

At the side of the door may sometimes be seen a shelf on which are placed the skulls of enemies. (Pl. LXII, fig. 2; Pl. LXIII, fig. 1.) At the corners of the house one also sees skulls of carabaos or pigs, carved wooden imitations of carabao horns, bunches of dried grass, and sometimes human skulls. I have seen an ornamental frieze of alternating carabao and human skulls on a level with the floor and extending halfway around a house. Hanging from the floor timbers are neatly woven baskets with small doors. In these the chickens are placed at night to prevent their being stolen or carried away by civet cats. (Pl. XXXII, fig. 2.)

The *Ifugaos* build rice granaries and also often construct, at a short distance from their own dwellings, little grass-thatched houses with tight board floors and sides, the crevices between the boards being chinked

The *Ifugao* eats his rice from a carved wooden bowl which may be single or double, or may take the form of a large vessel with four small ones attached to its perimeter. (Pl. XLVI, fig. 1.) The large bowl is used for serving boiled rice and the smaller ones hold salt, pepper, tomatoes, etc., with which the rice may be flavored. Forks and spoons, with handles carved in imitation of men and women, are in common use, as are bowls on the covers of which are carved pigs, carabaos, or figures of men and women. (Pl. XLVI, figs. 2 and 4; Pl. XLVII, fig. 2.) I have seen a lime-box made from a human bone, on which was scratched a picture illustrating the manner in which the original owner of the bone lost his life. (Pl. XLVI, fig. 3, *b*.) Lime-boxes ornamented with elaborate scratch-work patterns are frequently seen. (Pl. XLVI, fig. 3, *a*.)

Near, or under, the houses one sometimes finds large, artistically shaped wooden resting-benches, each large enough to accommodate two persons stretched out at full length. (Pl. XLVII, fig. 4.)

The *Ifugao* has been, and when not held in check, still is an inveterate head-hunter. The head-hunting feuds are strictly *rancheria* affairs. When some of the people of a given *rancheria* lose their heads, their friends make little or no attempt to take vengeance upon the particular individuals who took them but are content to get the heads of any of the residents of the settlement to which the aggressors belong. In the past, each *rancheria* has, as a rule, been at war with every other for miles around. Its people were ordinarily sufficient unto themselves and in many instances had little intercourse with outsiders for scores of years. It is doubtless due to this fact that a number of local dialects have sprung up, and that the *Ifugao* people, who really form a distinct and sharply marked tribe, have been subdivided into so many so-called tribes.

Heads taken in war are brought home by those who take them and are exposed at feasts which last for varying periods, their length depending upon the wealth of the victors and the importance of their victims. The skulls are then carefully cleaned and are used as household ornaments by those who took the heads, being either placed about the fireplaces, or at the doors or outer corners of the houses, or in a row at the level of the heavy floor timbers, or even, in some instances, hung in baskets under the eaves.

The arms of the *Ifugao* consist of a long shield in the form of a board, with a hand grip at the back, the lower end cut squarely off and the upper bluntly pointed (Pl. XI, fig. 1; Pl. LI, fig. 5); a steel lance with finely shaped head and wooden handle, reinforced with rattan lashings which are often colored red, and a broad bladed knife attached to a board sheath by means of one or two loose rattan lashings. The knife and sheath hang from the waistband of the owner's clout. (Pl. XI, fig. 1; Pl. LX, figs. 1, *c* and 2, *g*, *h*, and *i*.)

Small groups of houses are often surrounded by rice-paddies with high

and almost vertical walls, which make the approach of enemies difficult. (Pl. XXVI.) It is said that in repelling an attack in the terraced fields, bamboo lances, the points of which have been thrust into dead animals, are ordinarily used for throwing. Steel lances are usually reserved for thrusting, as they are too valuable to throw except in case of great emergency.

The only musical instrument in common use among the *Ifugaos* is the *gansa*, which is played with a drumstick. In the typical *Ifugao* dance both men and women take part. They form a line, the dancers in front and the musicians behind, and march back and forth with many rhythmical sidewise motions of the hands and arms and much flexing of the upper part of the body. This dance, which is common throughout the *Ifugao* country, is radically different from that of any other northern Luzon tribe. (Pl. LIV, fig. 1.)

I once attended the funeral of a man who had lost his head. (Pl. LXIII, fig. 2.) No *gansas* were used, but as the body was carried through the fields, the chief musician beat a tattoo on a piece of hard wood suspended by a cord in such a way that its vibrations were not interfered with. This piece of wood was painted black with white stripes. Behind the chief musician came five or six men carrying shields painted black, with zigzag, white stripes, and after the leader had beaten out a few notes he would stop while the men with the shields drummed a precisely similar series of beats upon them with wooden sticks.

Whatever may be the theoretically proper matrimonial state of the *Ifugao*, in practice he is not infrequently a polygamist. I have known a number of old and influential men who had wives of their own age and also a liberal assortment of young *queridas*.

The *Ifugao* wedding-dress is quite elaborate and striking. (Pl. XXIV, fig. 2.)

As already stated, the dead are sometimes buried in small houses especially constructed for the purpose. Not infrequently they are buried under the houses where they have lived, in the *Tingian* fashion, but the body of a man who has lost his head in war is placed in the ground, often on some lonely mountain top. (Pl. LXIV, fig. 1.)

I employ the name *Ifugaos* for the people of this tribe, because it has long been in general use with reference to a considerable number of them and seems to me more appropriate than any of the designations derived from the names of single *rancherias*. Some of the Bontoc *Igorots* call themselves *Ipukaos* or *Ifugaos*, but no *special* significance attaches to this fact, as the name *Ipukaos* or *Ifugaos* means simply "people." The Bontoc *Igorots* have always been known by the name of their principal *rancheria* and of the subprovince which they inhabit, and, as previously stated, I have deemed it desirable to retain this name for them.

Governor Villamor is of the opinion that the people of Lubo and Taloctoc are *Igorots*.

Dr. Jenks says that the Bontoc culture area stops short at Tinglayan, but does not tell us whether he has visited the latter place or any of the *rancherias* north of it. Of the *rancherias* listed by Captain Nathorst the only ones which I have visited are Balbalasan, Talalan, Sesecan, Patiquian, and Salcesec.

In my opinion, *Tingian* blood is predominant in Balbalasan, Talalan, and Sesecan, although that of the *Kalingas*, at least, is decidedly in evidence and becomes predominant in Patiquian, while the inhabitants of Saleesec are almost pure *Kalingas*.

More work must be done in several of these border *rancherias* before any final determination as to the exact limits of the territory of the Bontoc *Igorots* on the north and east can be reached.

The line between the territory of the Bontoc *Igorots* and that of the Benguet-Lepanto *Igorots* is well defined, the first *rancherias* of the latter tribe on the north and west being Quinali, Besao, Payeo, Bagnen, Bangnitan, Data, Sabangan, Bonayan, Pingad, Gayan and Namatoc.

DESCRIPTION.

The Bontoc *Igorots* are a tribe of Malay origin. While one occasionally sees individuals with curly or wavy hair, they do not show any of the other characteristics of *Negritos*, and if their curly hair is a consequence of the admixture of *Negrito* blood, such admixture probably occurred a very long time ago.

The Bontoc *Igorots* have been so carefully and fully described by Dr. A. E. Jenks, in his book entitled The Bontoc Igorot,[a] that any further extended description would be superfluous, and the facts essential to this discussion may be stated in summary form.

The men are of medium size, but their muscular development is magnificent, and they create the impression of being much larger than they really are.

Thirty-two individuals measured by Dr. Jenks averaged 5 feet 4½ inches in height. Of these, the shortest measured 4 feet 9½ inches and the tallest slightly more than 5 feet 9 inches. The average height of 29 women was 4 feet 9¾ inches, the tallest woman measuring 5 feet 4¾ inches and the shortest 4 feet and three-fourths of an inch.

The men are never corpulent and they are seldom very thin, except in extreme old age. The body is distinctly narrower at the waist than at the shoulders or hips. The buttocks are heavy, the legs straight, with thighs and calves splendidly developed; the hands and feet are broad and short; the skin is dark-brown, sometimes with a distinct, saffron tinge. (Pl. III, fig. 1; Pl. XI, fig. 2.) Individuals who have joined the Con-

[a] *Ethn. Surv. Pub.*, Manila, P. I. (1905), 1.

stabulary and as a result have worn clothes and bathed with frequency, have bodies so much lighter in color than their fellow-tribesmen that their appearance when they divest themselves of their uniforms never fails to create surprise.

The breasts of young women are large, full, and well supported; the hips broad and the waist scarcely narrower than the hips. The legs are very strong and are usually straight, with large calves and coarse ankles. The hands and feet are short and broad. (Pl. XIII, fig. 1; Pl. XXIV, fig. 1.) The women reach their prime at about twenty-three years, and at the age of thirty are beginning rapidly to grow old.

The hair-cut of the men strongly resembles that of the *Kalingas*, from which it differs only in that the cut extending over the ear is not usually continued so far back as with the members of the latter tribe. The hair over the forehead is banged squarely across, just as with the *Kalingas*, but the back hair, while allowed to grow long, is usually worn in a coil at the back of the head and is held in place by a cap, ordinarily of basket-work, but sometimes of wood. (Pl. IX, fig. 5.) Many of the men are very elaborately tattooed (Pl. VIII, fig. 4) and most of the women have tattoo marks on the arms. (Pl. XXIII, fig. 4.) Theoretically, the people of an *áto* (one of the political divisions of a Bontoc town) may be tattooed only when some person belonging to that *áto* has taken a head. However, the suppression of head-hunting in Bontoc has contributed to the breaking up of this custom, and undoubtedly a large amount of tattooing is done at present when no heads have been taken.

In every *rancheria* there are one or more men who are skillful in tattooing. The desired design is first drawn with a mixture of soot and water upon the skin of the person to be operated upon, and the tattooer then pricks the skin, following the lines of the design. After the design has been pricked in, soot is rubbed into the wounds thus produced. This causes the flesh to rise in great welts, which sometimes become infected and cause serious trouble.

The Bontoc *Igorots* recognize three kinds of tattoo. First, that on the breast, usually running upward from each nipple, curving out on the shoulders and ending on the upper arms. This indicates that the person so marked has taken a head. Second, the tattoo on the arms of men and women. Third, all other tattoos of both sexes. The women are tattooed only on the arms.

Dr. Jenks states that tattoo marks on the face, arms, stomach, and other parts of the body are believed to be purely esthetic, but other observers have remarked that it is often possible to determine from a man's tattoo marks the *rancheria* to which he belongs. With the Bontoc *Igorots*, as with a number of the other northern Luzon tribes, tattoo marks, because of their supposed therapeutic value, are put on goiters, tumors, and varicose veins.

The people of this tribe do not blacken their teeth, as do the wild *Tingians* of Apayao, nor do they chew betel nut.

Adult men usually wear a clout (Pl. III, fig. 1), although its place may be taken by a girdle about the waist and a bag attached to the girdle, which hangs down in front and serves the double purpose of apron and pocket. Very old men not infrequently have blankets, but young men scorn to use them. In addition, every man has a small cap, usually made of basket work, but sometimes of wood, which is worn on the back of the head and helps to confine the back hair. (Pl. VI, figs. 1 and 2; Pl. IX, fig 5.) In a few of the southern and western towns, where the men have cut their hair in imitation of the Benguet-Lepanto *Igorots*, a head-band is worn instead of this cap. In addition to the articles above mentioned, many of the men possess conical rain-hats covered with wax and thus made waterproof, and all have basket-work sleeping caps.

The ordinary dress of the women consists of a single, short piece of cloth woven from bark fiber which is wrapped about the body and extends from the waist to the knees. The opening between the two ends usually comes along the outside of the right leg. This skirt is held in place at the waist by a girdle of similar material. From the ends of this girdle there project long threads on which are strung seeds resembling the beads commonly known as "Job's tears." (Pl. XIII, fig. 1.) Most of the women also own cotton blankets, which are worn for warmth in inclement weather and also when the owners are dancing. (Pl. LIV, fig. 2.)

Women as well as men often strip before wading streams, and it is not unusual to see adults of both sexes going about entirely naked during rainy weather, or when engaged in dirty field-work.

Both men and women wear quite elaborate ornaments. Small holes are pierced through the lobes of the ears and are then stretched by forcing into them a constantly increasing number of small pieces of wood, about the size of matches, until they reach huge dimensions. (Pl. XXI, fig. 1.) Into these holes are thrust great rings of bamboo or blocks of wood in which coins, pieces of metal or of looking-glass, or bits of brightly colored stone may be set. At times, brass, silver, or gold ear ornaments of a pattern resembling those seen among the Benguet-Lepanto *Igorots* are used. (Pl. VI, figs. 1 and 2; Pl. XVIII, figs. 1 and 2.)

The men often wear in their hair brass tobacco-pipes of more or less elaborate design, from the bowls of which hang metal chains supporting metal pipe cleaners. (Pl. VI, fig. 1.) Huge earrings of metal are sometimes seen and the spoons of the unwary traveler are apt to disappear temporarily, reappearing later in the ears of the thief, after undergoing a very complete metamorphosis. The men often wear about the waist, chains of highly polished copper or brass wire (Pl. III, fig. 1), and about the neck, necklaces of seeds, boar's tusks, or dog's teeth. Armlets of boar's tusks, worn above the elbow, are quite common.

Perhaps the most highly treasured ornament of the men is made from one of the valves of a pearl-oyster shell. (Pl. III, fig. 1.) The fortunate owner of such an ornament wears it suspended from the waistband of his clout or from a chain or girdle about the waist. Armlets and leglets of copper wire are common. Finger-rings are relatively rare. I have seen men with pieces of coral thrust into their hair or through the holes in their ears.

The women are fond of copper-wire armlets and leglets, but seldom wear chains about their waists. Strings of beads or of dog's teeth and bright-colored seeds are highly prized. (Pl. XVIII, fig. 1; Pl. XXIII, fig. 4.) Unmarried women often wear flowers or bunches of green foliage in the hair, which is carefully dressed and held in place by strings of beads. The women do not ordinarily possess hair combs, but are very glad to get them. Many save their loose hair and wear it in the form of switches. (Pl. XXI, fig. 2.)

The houses of the Bontoc *Igorots* are usually closely grouped, forming genuine towns which often number several thousand inhabitants Each town is made up of a number of political divisions known as *atos* which, for want of a better name, we may call wards. The affairs of the *ato* are presided over by a council of old men, and delegates from each of these councils sometimes meet to discuss affairs which concern the town as a whole.

In each *áto* there ordinarily are three public buildings which may be placed in close proximity to each other. (Pl. LXIV, fig. 2.) One of these, called the *pabafunan*, is the house of the *ato* ceremonials. It is reserved for the men and boys of the *áto*, and women may not enter it. Boys of more than three or four years of age and all unmarried men of the *áto* sleep in the *pabafúnan*. It consists of an open, stone court, partially covered by a roof. About this court there may be trees, and one ordinarily also sees posts on which rude images of human heads are carved, or dead limbs of trees with the ends sharpened of the branches which project upward. On these posts and sharpened branches the heads of vanquished enemies are placed during the head feast The *pabafúnan* is incidentally the men's club of the Bontoc settlement. In it the men loaf when not busy at home or in the fields, and they naturally improve the opportunity to exchange gossip and discuss current events.

The *fawi* or *áto* council house is used as a place of meeting by the old men, and other persons are not ordinarily allowed to enter it. It is roofed over, and although often adjoining the *pabafúnan*, is not in connection with it, entrance being had by a separate and very narrow door. In the *fáwi* are kept the skulls of enemies whose heads have been taken by the warriors of the *áto*.

The *ólag* is the dormitory for girls, and unmarried femals of the *ato*, of two or more years of age are expected to sleep there. It has but one opening, a door some thirty inches high and often not more than ten or

twelve inches wide. Its floor is covered with boards about four feet long by eight to fourteen inches wide, each board serving as a bed for one of the girls. In some *átos* the *ólag* is lacking, in which case the girls go to the *ólag* of some other *áto* to sleep; or there may be two *ólags*, if the number of girls and unmarried women is large.

The typical Bontoc family dwelling house is the place where a man, his wife, and his children less than two years of age sleep and where the entire family eats. In the *rancheria* of Bontoc it is practically always constructed on a fixed plan. (Pl. XXXIII, fig. 1.) The walls are about three and a half feet high; the front wall is open in the middle; the front and side walls are built of boards, but the rear one is of stone, chinked with clay. There is a post six or seven feet high at each of the four corners of the building; the boards of the side walls are tied to these posts, which also support the greater part of the weight of the roof. There is no floor on the first story. On the left, as one enters, is a small room partially marked off by stones sunk in the earth. In this room rice is hulled, millet is threshed, and food is prepared for cooking. Next to this room on the left comes one in which the food is cooked. Down the center of the house extends a passageway and to the right as one enters there is a shelf or bench on which are placed various household articles.

At the rear is a sleeping box, extending from one side of the house to the other, so that the side walls make its ends and the back wall forms its back side. It has a front side and a top of wood, and is entered by means of a small door. This box is sometimes lined on the inside with stone, except at the point where the door gives entrance to it. It contains sleeping boards for the husband and wife, and in one end of it a fire is built for warmth. Many of the Bontoc *Igorots* suffer from serious eye trouble, which doubtless has its origin in the constant irritation caused by the smoke in their sleeping boxes.

The roof of the house extends nearly, but not quite, down to the level of the sides and projects beyond them for some distance. In its peak there are ordinarily two rooms, one above the other. Entrance is had to the lower by means of a door and short ladder. It is used as a storeroom. The second room must be entered from the first. It is sometimes used as a storeroom and sometimes stands empty. The roof of the house is well thatched with grass. Under the eaves, firewood is stored.

Dwelling houses of very different types may be found in many of the other *rancherias* of the Bontoc *Igorots*, and even in the settlement of Bontoc itself, those inhabited by widows are sometimes mere huts.

The fish of the Bontoc streams are few in number and are usually small in size, but the people manage to secure a considerable supply of them either by catching them with their hands under stones in the streams or by chasing them into wickerwork baskets or traps. (Pl. L, fig. 1.)

Traps are also set for jungle-fowl and for small birds and mammals. Wild carabaos are hunted by large bands of warriors, who lie in wait by their runways and attempt to spear them when they pass. This form of sport is attended with a good deal of danger, as a wounded carabao is a fierce and determined fighter. Dogs are sometimes kept for running deer and hogs. Deer are relatively scarce in Bontoc, but hogs are quite abundant. When brought to bay by the dogs, they are killed with lances, the use of the bow and arrow being unknown among the Bontoc *Igorots*. Deer and hogs are also taken in pitfalls and dead-falls.

The agriculture of the Bontoc *Igorots*, like that of the *Ifugaos*, is very highly developed for a people otherwise so primitive. As the country which they inhabit furnishes little game and fish, they are very largely dependent upon the fruits of agriculture for a livelihood. They build wonderful irrigation dams and ditches and terraced rice-fields which often extend far up the mountain sides. (Pl. XXXVIII, fig. 1.) The ground, after being flooded, is prepared for planting with no other implements than sharpened sticks and the hands and feet of the laborers. Men and women join in this work, and may not infrequently be seen working side by side in a state of absolute nudity, their clothes having been discarded in order to prevent injury to them by mud and water. However, more frequently the women leave their girdles on, and attach bunches of leaves or grass to them in lieu of skirts. (Pl. XXIV, fig. 1.)

The two principal crops are rice and *camotes;* the former grown under irrigation, and the latter as a rule high up on the steep mountain sides. However, in some cases a crop of *camotes* is grown on the rice-terraces during the dry season, and in rare instances one sees terraces which are given up exclusively to the cultivation of these tubers.

The Bontoc *Igorots* also raise a considerable quantity of millet, beans, and maize. Their cultivated fields are fertilized with care. They have well-established property rights over them and also have rules relative to the use of irrigation water, which are designed to insure its equitable distribution.

Rice is first sown thickly in seeding beds, and when it has sprouted is transplanted by hand. During the entire period of growth it is kept carefully weeded and is thinned out as occasion may require. After it has headed, constant care is necessary to protect it from the depredations of hogs, monkeys, rats, and birds. In this, as in all other work, the Bontoc *Igorots* display great patience and industry.

Before the rice harvest is begun, a brief ceremony is performed in a pathway adjoining each plot where harvesting is to go on. Tall stalks of *runo* grass are then set as a warning to other *Igorots* that harvesting is in progress and they must not pass that way. Persons violating this rule are subject to heavy fines.

More attention is paid by the Bontoc *Igorots* to domestic animals than is given by the *Negritos*, *Ilongots*, or *Kalingas*. Pigs are kept in large

pipe bowls. Wooden pipes are manufactured by the people of all the towns.

Head-axes and lance-points are fashioned from iron and steel at Baliwang, and axes which, by a change in the position of the head on the handle, can readily be converted into adzes are produced in considerable numbers.

Ceremonial drinking cups and lime-boxes, ornamented with scratch-work patterns, or with quite elaborately woven lashings of vegetable fiber, are made from bamboo. Bowls, troughs, and ladles are fashioned from wood, and pig-troughs are sometimes hollowed from stone. The elaborately carved wooden spoons, forks, bowls, and other wooden dishes so common among the *Ifugaos* are conspicuous by their absence. So called *anito* posts, carved from tree-fern trunks, are sometimes seen in the fields or beside the trail. (Pl. XLVIII, fig. *a*.)

One town of Bontoc, Mayinit, has an important and unique industry in the manufacture of salt from a brine which flows from boiling springs. This brine is led to clay courts roughly paved with small stones and roofed over to keep off the rain. It flows among the stones, evaporating by its own heat and depositing its salt. When a sufficient amount has been deposited on the lower surface of the stones, their position is reversed. When they are entirely covered they are taken out, the salt is washed off, and the strong brine thus formed is evaporated in kettles over fire. The salt thus produced is made into cakes and dried and then becomes an important article of *Igorot* commerce.

Until within a short time the Bontoc *Igorots* have been persistent head-hunters, but this practice is now rapidly disappearing. Dr. Jenks states that the possession of a head is in no way requisite to marriage, and that the heads of enemies have no part in the ceremonies celebrated in order to secure good crops, good health, or for other similar purposes; that they do not affect a man's wealth, nor his supposed fortune in the wo ld to come. He accounts for the persistency with which head-hunting is indulged in on the basis that a man desires to be considered brave by his neighbors and his descendants, and that he also needs activity and excitement.

It does not appear that Dr. Jenks had any opportunity personally to investigate the head-hunting customs of the Bontoc *Igorots*. Information received from other sources leads me to believe that the taking of a head is of very real assistance to a Bontoc man in making a good match. If the heads taken are of so little use, how are we to account for the undoubted fact that the cash value of a head in Bontoc was, until recently, a hundred pesos, a very large sum among such poor people?

The Bontoc warriors are brave men, and instead of murdering their victims from ambush, as do the *Ilongots*, they not infrequently send formal challenges to the enemies with whom they wish to fight. When a challenge is accepted, an open attack is made by the inhabitants of one

town on the other. Challenges may be refused, and there are regular, established procedures for breaking the peace between towns, and for reëstablishing it.

When a warrior takes a head, he usually returns at once to his town and placing the trophy in a funnel-shaped receptacle fastens it to a post in the stone court of the *fáwi*. A short ceremony lasting a day and a night, at which a dog or a hog is killed, is immediately inaugurated, and on the following night there begins a ceremony which lasts for a month. At the outset the head is taken to the river and washed, the lower jawbone is cut off, cleaned, and reserved for use as a *gansa* handle. (Pl. LV, fig. 1.) On the evening of this day the head is buried under the stones of the *fáwi*, while the ceremony continues. Endless dances are held, and carabaos, dogs, hogs, and chickens are killed and eaten. After the head has been buried for approximately three years, it is dug up, and the skull, after being thoroughly washed, is placed in a basket with other skulls and hung in the *fáwi*. (Pl. LXIV, fig. 3.) Another feast is celebrated at this time. The skulls are ultimately again buried under the stones of the *fáwi* and, in fact, some of the *rancherias* do not dig them up at all. The body of a warrior unfortunate enough to lose his head is buried without formal ceremony under the trail leading to the town of the man who took it. On the day following such a burial, the people of the *áto* to which the victim belonged have a fishing ceremony, and eat fish for the evening meal. On the succeeding day they go to a spot near the place where their companion lost his head and ask his spirit to return to their town.

The Bontoc warrior is usually armed with a broad-bladed head-axe, a steel-headed lance, and a good-sized wooden shield. (Pl. XI, fig. 2.) Lance-heads are variously shaped, some of them being mere plain blades, while others have from one to four pairs of barbs. (Pl. LX, figs. 2 *j*, *k*, *l*, and *m*.) In the *rancherias* of Amboan, Agawa, Sagada, and Tetepan most of the warriors use head-knives or bolos instead of head-axes.

The Bontoc *Igorots* have a number of musical instruments, including "jew's-harps" made of bamboo or brass, bamboo flutes and *gansas*. Of these, the *gansa*, which is in such general use among the non-Christian tribes of northern Luzon, is by far the most important. It is made of copper or brass, and is suspended from a handle which theoretically should be and practically often is, the lower jawbone of an enemy killed in a battle. (Pl. LV, fig. 1.)

The Bontoc *Igorot* does not beat his *gansa* with his hands as does the *Kalinga*, *Tingian*, and *Ifugao*, nor with a bit of wood as does the Benguet-Lepanto *Igorot*, but uses a well-fashioned, skin-covered drumstick.

He dances while he plays, and in the dance both men and women participate. In one of the common dances the men form a long line which winds in and out through the crowd of spectators, while the dancers pound their *gansas* and execute some very fancy steps. This dance is

participated in by women who do not join the line, but keep near it, dancing with outstretched arms and with much rising on tiptoes and descending on the flats of the feet.

In the head-dance, the chief actor goes through the motions of hunting down and killing his enemy, taking his head, etc., dancing meantime to the accompaniment of *gansas* played by men who at the same time themselves dance, as do the women who happen to be near. (Pl. LIV, fig. 2.)

In another dance the men form a line with their arms about each other's necks, and the women form a similar one immediately behind them. The man at the right holds in his hand a stick which he stretches toward the ground from time to time. This dance is executed to the tune of rather mournful singing by the participants, and is accompanied with much flexing of the body and legs. (Pl. LV, fig. 2.) It is said to be performed in connection with funerals. All of the dances of the Bontoc *Igorots* are spirited and striking affairs.

The Bontoc *Igorot* is monogamous. He has but one wife and is usually faithful to her. However, he has the peculiar custom of trial marriage, a young couple establishing a temporary union while the girl is still living in the *ólag* and leaving future events to determine whether this union shall become permanent. The advent of a child usually settles the matter in the affirmative.

Unfruitful unions generally lead to divorce, separation being accomplished by mutual consent between husband and wife. In case either party to a marriage deserts the other, he or she must pay a fine of one or more rice plots or other valuable property. If either party dies, the other must not remarry for at least a year.

Theft, lying to shield oneself from the consequences of evil deeds, assault and battery, adultery and murder are recognized as crimes by the Bontoc *Igorots*. There are a number of interesting tests to determine which of several suspected persons is guilty of a crime, but I will not describe them, as we have not sufficient knowledge of similar practices among the other northern Luzon tribes to establish a comparison of importance. However, it should be said in passing that one of these is the rice-chewing test, in which each of the suspected persons is made to chew a mouthful of raw rice, and to spit it out at word of command. Each mouthful is then examined, and the person whose rice is driest is considered guilty, it being supposed that the guilty one will be frightened during the trial and that the flow of saliva will consequently be checked. This same test occurs among the *Tagbanuas* of Palawan and the *Mangyans* of Mindoro.

The Bontoc *Igorots* believe that sickness and death are caused by *anitos*. They have medicine for wounds, burns, and headaches. They poultice boils and other sores, and make a salve of millet and charcoal to use in curing the itch. Toothache is treated with salt mixed with

pounded herbs. A decoction of certain leaves is used to cure smallpox, but in ordinary cases of severe illness the measures taken are purely of a nature calculated to appease the *anitos* who are believed to be making the trouble.

Death is taken very quietly by the living. A woman weeps a day for a child or a husband, but men do not weep over the death of friends or relatives. There is no long or loud lamentation as with the *Ilongots*. The body, wrapped in a blanket on which are woven white *anito* figures, is placed in a rudely fashioned chair and set inside the house, immediately in front of the door. Feasting and drinking then begin and last for a time which varies with the wealth and importance of the deceased.

There is no field work in an *áto* on the day when an adult person is buried. The body is placed in a coffin and buried in the ground. When the coffin has been lowered, the grave is filled as quickly as possible in order to avoid evil portents, such as the crowing of cocks, the barking of dogs, and the crossing of the trail by snakes or rats. The bodies of persons of importance are buried at the outskirts of the town; those of ordinary persons in the fields near their houses; those of children are not placed in coffins. The bodies of very young children are buried close to the houses in order that the children may be afforded protection. After a burial, the relatives return to the house of the deceased and pass the night there, a ceremony being performed with the apparent objet of propitiating his *anito*. On the following day all the male relatives go to some neighboring stream and fish. That evening they have a fish festival to which all the ancestral *anitos* are invited. The second night is also spent at the house of the deceased, after which the relatives retire to their homes at night. The funeral rites last from two to eight days.

In general it may be said of the Bontoc *Igorot* that, although a pagan, he is brave, industrious and intelligent, and is possessed of a strong sense of humor which leads him at times to play practical jokes even upon white men. He has shown himself rather docile in the matter of giving up head-hunting. He responds readily to the discipline of military service, and makes a good soldier. All in all, there is much hope that he ultimately will make great progress in civilization and in material prosperity, but his intense conservatism will, at the outset, render such progress slow.

The boys are bright and learn rapidly. They also indulge in vigorous, not to say rough, play, and laugh and shout like small American boys, presenting in this particular a pleasing contrast to the silent and timid children of the civilized towns.

I incline to believe that Rizal's statement that the hope of the Philippines lies in the people of the mountains is worthy of more serious consideration than has hitherto been accorded to it. At present, very few of his countrymen are really interested in the work of civilizing the wild

tribes. It is to be hoped that the number of such persons will increase in the not very distant future. Meanwhile, the average wild man accedes with much better grace to suggestions from a white man than to those made by a civilized Filipino.

Tribe VI. THE BENGUET-LEPANTO IGOROTS.

The non-Christian people of the Province of Benguet and the subprovince of Lepanto call themselves *Igorot*, and the name *Igorots* might, with entire propriety, be assigned to them as a tribal designation were it not that no satisfactory name for the Bontoc people except that of Bontoc *Igorots* has thus far been suggested, and it therefore becomes necessary to distinguish between the *Igorots* of this subprovince and those of Benguet and Lepanto.

SYNONYMY.

BENGUETANOS. Name applied to *Igorots* of Benguet.
IGUDUT. Synonym of *Igorot*.
YGOLOTES. Synonym of *Igorots*.
YGOROT. Synonym of *Igorot*.

HABITAT.

The entire Province of Benguet, including the former *comandancia* of Kayapa; the mountains of that portion of Union Province which borders on Benguet and Amburayan; the entire subprovince of Amburayan with the exception of the township of Sigay, where there are a number of *Tingians;* the hills bordering upon Amburayan and South Ilokos, and the entire subprovince of Lepanto with the exception of the townships of Angaki, Concepcion, and San Emilio, in each of which there are considerable numbers of *Tingians*.

The *rancherias* inhabited by Benguet-Lepanto *Igorots* which border upon the territory inhabited by the Bontoc *Igorots* have already been listed.

It should be noted that in the mountains of northeastern Benguet there live, in inaccessible places, a people called by the Benguet Lepanto *Igorots* "Busaos." This word means "enemies" and is not a tribal designation. The people to whom it is applied are Benguet-Lepanto *Igorots* and speak the Kankanai dialect.

DESCRIPTION.

The Benguet-Lepanto *Igorots* are of lower stature than are the Bontoc *Igorots* and *Ifugaos*, but as a result of inhabiting a very healthful mountain country they are remarkably strong and well developed. Many of them have large and very beautiful eyes. Their skins are of the usual dark shade of brown, although often darkened by earth and soot and by long continued exposure to the sun. The men usually wear their hair cut moderately short. The women bang the hair which hangs over the forehead, but allow the rest of it to grow moderately long and wear it hanging down their backs.

The usual costume of the men is a clout, supplemented, whenever the means of the individual will permit, by a cotton blanket, which is wrapped around the upper part of the body to protect it from the cold breezes of the mountains. (Pl. III, fig. 2.)

At the present time many of the men have adopted civilized dress. Old hats and blue flannel shirts are especially desired. Trousers they don with some reluctance. It is considered etiquette for the presidents and councilors of the *rancherias* to wear civilized dress during office hours and on state occasions. Many of them discard their trousers as soon as these hours are over, and some of them request vacations from time to time in order that they may go back to their clouts and "rest."

The Benguet women, unlike those of any other non-Christian tribe in northern Luzon, habitually clothe the entire body. Their working costume consists of a skirt reaching to, or a little below, the knee, a long-sleeved upper garment and a towel or a piece of cloth coiled about the head in the manner of a turban. The poorer women, on state occasions, and the wealthier ones when not at work, wear garments of brightly colored cloth. Three or four skirts may be superimposed one over another, like Japanese kimonos (Pl. XIII, fig. 2), and the same holds true of the upper garments. From childhood, the *Igorot* women are accustomed to carry heavy burdens in baskets on their backs. In order to save their clothes, when carrying they usually put their upper garments on with the back side forward, leaving their backs bare, so that the wear from the baskets may come on their skins rather than on their much-cherished clothes. Occasionally also, when at work in the fields or in the privacy of their homes, they remove their upper garments, which are, however, always promptly donned if a stranger appears.

The men of southern Benguet usually have the hair cut quite short all over their heads and often wear pieces of cloth coiled around their heads turban fashion. (Pl. VI, figs. 3 and 4; Pl. IX, fig. 6.) The women usually bang their hair across their foreheads, but allow the rest of it to grow moderately long and to hang down their backs. They almost always wear towels or pieces of cloth bound around their heads so as to form rude turbans, and if their hair is long enough to cause them annoyance when at work, it may be bound up at such time. (Pl. XVIII, figs. 3 and 4; Pl. XXI, fig. 3.)

Both men and women are sometimes tattooed, the women more frequently than the men. The tattoo marks are chiefly confined to the hands and arms (Pl. XXV, fig. 2), although sometimes they are made upon goiters and tumors because of their supposed curative effect. The men often have conventional tattoo marks, representing the sun, on the backs of their hands.

They have few ornaments, but sometimes wear earrings of copper, silver, or gold, and leglets of copper wire. A few of the men have metal pipes, and many of them carry a set of metal toilet articles consisting of ear spoons of different forms and pinchers for pulling hair from the face or body. The women have ear-ornaments similar to those of the men (Pl. XXV, fig. 3*a*), and occasionaly bedeck themselves with beads. Some of the women of Kabayan have thin bands of solid beaten gold

which are worn between their lips and front teeth, completely closing their mouths. (Pl. XXI, fig. 3.) These gold bands are no longer made, the ones which exist having been handed down by the ancestors of the present generation.

In the vicinity of Suyok, large, and strangely fashioned, gold ornaments, which, for want of a better name may be called brooches, are occasionally met with. (Pl. XXV, fig. 3*b*.)

The Benguet-Lepanto *Igorots* usually live in well-defined settlements (Pl. XXVIII, fig. 1), although occasionally one finds single families inhabiting remote and inaccessible mountain fastnesses. The dwelling house may have a grass roof and sides and be placed on the ground, or it may have board sides with a thatched roof, and be either placed on the ground or raised several feet above it on piles. (Pl. XXXIII, fig. 2; Pl. XXXIV, fig. 1.) Frequently it has a platform under the eaves, on which the occupants sit during rainy weather. It is sometimes lighted and ventilated by but a single door, but may have two or more doors and several windows. It is almost invariably black with soot on the inside, the cool weather of the mountains making a fire constantly necessary.

In the *rancherias* along the Bontoc border and in some of those in Amburayan the houses are built on the ground, with low sides and very high peaked roofs, each roof containing a small room, to which there is access by a ladder and in which rice and other commodities are stored. (Pl. XXXIV, fig. 2.)

Rice-granaries and pig-pens are the only other structures ordinarily made by the Benguet-Lepanto *Igorots*, unless, indeed, that name be applied to the ceremonial platforms usually found near their houses, on which are placed offerings to propitiate the spirits.

The boards and timbers used for house construction are hewed from pine trees and are rarely carved or ornamented, although there are exceptions to this general rule.

The streams of Benguet and Lepanto contain even fewer fish than those of Bontoc and Nueva Vizcaya. Nevertheless, with traps and with their bare hands the people manage to catch a few small fish (Pl. L, fig. 2), and they sometimes spear eels of large size.

Deer and wild hogs, which are fairly abundant, are hunted with dogs and killed with lances. The use of the bow and arrow is unknown among the people of this tribe.

The agriculture of the Benguet-Lepanto *Igorots* is not so well developed as is that of the Bontoc *Igorots* and the *Ifugaos*, although they sometimes construct quite extensive, terraced rice-paddies. The walls of these terraces are almost invariably made of mud, but in the vicinity of Kabayan, in Benguet, one sees stone walls. *Camotes* are the staff of life, rice being more or less of a luxury. *Camotes* are usually grown on the steep mountain sides, and after two or three crops have been raised the land is allowed to rest for some time before being planted again. Tomatoes,

squashes, and *taro* are grown to a limited extent. Fine bananas are raised in abundance and good mangas are to be had in the warmer valleys. Considerable coffee is raised at Daklan and Kabáyan, in Benguet. (Pl. XXXVIII, fig. 2.)

The Benguet-Lepanto *Igorots* keep dogs for hunting purposes and for household pets and also bring in from the lowlands a large number of these animals which they eat. They raise chickens and pigs in considerable numbers, the latter being mostly reserved to be eaten on state occasions. Their pigs, which are well cared for and sometimes attain a large size, are of a type distinctly better than that of those kept by the civilized natives of the lowlands. Carabaos, cattle, and horses are raised in considerable numbers. The men are good horsemen and ride skillfully either with or without saddles. (Pl. LI, fig. 3.) They have very little consideration for their horses, and often run them up and down hill. Many of the women also ride. (Pl. LI, fig. 1.) Chickens, pigs, carabaos, cattle, or horses which die of disease are promptly eaten.

The Benguet-Lepanto *Igorots* roll their own cigars and prepare from rice a fermented drink known as *tapuy*. Their manufactures of wood are limited to images or *anitos* (Pl. XLIX, figs. 1, *a*, *b*, *c*, and *d*), the rude ladles and bowls or trays used in cooking and serving food (Pl. XLIX, fig. 2, *c*), carrying-boxes (Pl. XLIX, figs. 2, *a* and *b*), and carved walking-sticks, spoons and small, wooden dishes, which are produced in some quantity by the people living in the vicinity of Bugias. (Pl. XLVIII, figs. *c*, *d*, and *e*; Pl. XLIX, figs. 1 and 2.) The men have mined gold for centuries. They work over the faces of exposed cliffs, when necessary suspending themselves by means of rattans, and pick out the streaks of rich ore which show free gold. This they dig with their crude iron or steel implements, the use of powder being unknown among them. The ore, after being dug, is crushed and panned.

Both men and women also wash gold from the sands of the streams, and the women are especially famed for the skill with which they save the very light float gold—a skill which American miners have found it impossible to attain. The gold is usually sold in the form of dust, although it is sometimes melted and run into ingots.

Many of the *Igorots* of northern Benguet and southern Lepanto mine copper and smelt it by a process of their own. From the metal thus obtained they fashion *ollas* and kettles which frequently are of large size. The method employed in making kettles is kept secret by those familiar with it, and numerous attempts on the part of Americans to surprise coppersmiths at their work have proved abortive. At one time a considerable business was done in the vicinity of Suyok in making rude counterfeits of Spanish copper coins. Clay molds were taken from genuine coins, and into these molds the copper was run. These counterfeits, although quite recognizable as such, circulated freely for some time because of the shortage of small change.

The *Igorots* of Benguet make little or no cloth, but some of those of Lepanto bordering on the *Tingian* country have learned the art of weaving from their neighbors, and the same is true of some of the inhabitants of the *rancherias* near the Bontoc border, who weave beautiful blankets. Basket ware of good quality and in considerable variety is quite generally manufactured.

The Benguet-Lepanto *Igorots*, both men and women, carry burdens on their backs as do the Bontoc *Igorots*, differing in this respect from the *Ifugaos* who, so far as possible, carry everything on their heads.

Although seventy-seven years ago the *Igorots* of Benguet offered armed resistance to the Spaniards who first entered the province, they are now the most pacific of people. When the first Spanish expeditions penetrated their territory, the Benguet *Igorots* seem to have used bows and arrows, but this is no longer the case. In an emergency it is still possible for them to hunt up a few old shields and lances, but many years have passed since they have made war on any other tribe or committed any act of armed aggression. They do not take heads, and there seems to be no evidence that they have ever done so. Their war shields were, it is said, usually ornamented with the carved figure of a man. (Pl. LXI, figs. 1, *d* and 2, *d*.) Lances are far more commonly met with than shields at the present time. They have been retained because they are useful in hunting. In general, their heads are smaller and less well made than are those of the lances of the Bontoc *Igorots*, which they resemble in shape.

The music of the Benguet-Lepanto *Igorots* is highly characteristic, and several instruments are used in producing it. Of these the most peculiar is a pair of long, slender-barreled wooden drums, open at one end and having the other covered with pigskin or lizard skin. (Pl. LVI, figs. 1 and 2.) These drums are played with the hands. The operator can change the pitch of the tones produced by pressing his arm or leg, or both, against the wooden barrel. The *gansa*, which is always used when music is wanted, is played with a short stick or slat of bamboo. (Pl. LVI, figs. 1 and 2.) Usually there is also one musician who beats together a stone and a bit of steel or iron. During certain months of the year a Benguet *Igorot* woman will not go on the trail without carrying and constantly playing the bamboo musical instrument shown in Plate LIX, figs. 1, *b* and *c*. This instrument is carried in the left hand and is made to vibrate by striking one of its prongs against the right wrist. The character of the sound thus produced is changed by thumbing the hole near the septum at the undivided end. The Benguet *Igorots* are also fond of vocal music. They sing frequently at their feasts and occasionally when on the trail or resting beside it.

In the dance which is most commonly seen, a man with outstretched arms from which blankets are hung represents a bird. He dances with active movements of the feet and with much flexing of the arms, wrists, and hands. His fair partner dances with her hands stretched upward

refused to allow their girls to go to school, but their prejudices have now been overcome to some extent and an interesting experiment in the education of girls is being conducted at Baguio.

Tribe VII. THE TINGIANS.

SYNONYMY.

APAYAOS. Name applied to the *Tingians* living in the district of Apayao, Cagayan.

APAYOS. Synonym of *Apayaos*

APOYAOS. Synonym of *Apayaos*.

BANAOS. Name applied to the *Tingians* of the upper Saltan River Valley and the *rancherias* of Guinaan and Balatoc

BURICS. Name applied to the *Tingians* of the Cordillera Central in northern Abra.

BUSAOS. Name applied to the *Tingians* of the mountains of Siguey, near Benang, Abra.

ECNIG. Synonym of *Itneg*.

GINAN. Synonym of *Guinaanes*.

GUINAANES. The name applied to the *Tingians* of Guinaan and neighboring *rancherias*. The statement of the Jesuits that these people are Malay-*Negritos* is incorrect. They show no evidences of *Negrito* blood

GUINANES. Synonym of *Guinaanes*.

ITANEG. Synonym of *Itneg*

ITAVEG. Synonym of *Itneg*.

ITETAPANES. Said by the Jesuits to be a tribe "contiguous on the south with the *Igorots* of Benguet, on the north with the *Guinaanes*, and on the west with the *Busaos*." No such people exist at the present time. In point of fact this name was probably applied to the inhabitants of Tetepan.

ITNEG. The name universally applied by the *Tingians* to themselves.

QUINAANES. Synonym of *Guinaanes*

QUINANES. Synonym of *Guinanes*.

TINGGIANES. Synonym of *Tingians*.

TINGUES. Synonym of *Tingians*.

YTATAPANES. Synonym of *Itetapanes*.

HABITAT.

The stronghold of the *Tingians* is the subprovince of Abra, where they make up approximately 50 per cent of the population. Numerous *Tingian rancherias* are found in the eastern mountains and foothills of Ilokos Sur and Ilokos Norte, and the inhabitants of the Ablug River Valley, including the old Spanish *comandancias* of Cabugaon and Apayaos and in general the district which has been known as Apayaos, belong to this tribe. It extends south along the eastern slopes of the Cordillera Central as far as Dagara. South of this point the *Tingians* give way to the *Kalingas*, only to reappear again along the headwaters of the Saltan River at Seseean, Balbalasan, Balatoc, and Guinaan. In these latter *rancherias* they have intermarried somewhat with the *Kalingas* and Bontoc *Igorots*. There are considerable numbers of them in the *rancherias* of Tiagan, Concepcion, and Angaki, in the subprovince of Lepanto, where they are living with Benguet Lepanto *Igorots*. The same condition of things prevails in the township of Sigay, in the subprovince of Amburayan. Finally, there are a number of settlements of

Tingians who have been converted to Christianity, in the vicinity of Rosario and Pozzorubio in Pangasinan, near the mouth of the Bued River canyon, and strangest of all, there is a single *Tingian rancheria* called San Marcelo in the Province of Nueva Ecija. A band of wandering *Tingians* has even been observed by Dr. Barrows in Pangasinan.

DESCRIPTION.

The name *Tingians* or *Tinguianes* has long been applied to the non-Christian inhabitants of Abra and to certain of those of the western slopes of the eastern mountain ranges of Ilokos Norte and Ilokos Sur. These people call themselves *Itneg*, and this appellation would be a fitting tribal designation for them, but the name which I have adopted has been so long and so generally in use that it seems undesirable to change it.

Many of the *Tingians* of Abra and of Ilokos Norte and Ilokos Sur are possessed of a degree of civilization quite equal to that of their Ilokano neighbors, but the inhabitants of some of the settlements of Ilokos Norte and Ilokos Sur and of eastern Abra are not far advanced in civilization. Until very recently the wildest of all the known *Tingians* were the people of Guinaan and Balatoc, in Bontoc, and of Balbalasan and other settlements along the headwaters of the Saltan River.

The people of the district of Apayao have long been known under the name *Apayaos*, although their immediate neighbors call them *Kalingas*. On a recent trip through this hitherto almost unknown region I was greatly surprised to discover that they were *Tingians*, but *Tingians* with a degree of civilization comparable to that possessed by those of Abra a century and a half or two centuries ago. They themselves trace their ancestry without hesitation to the *Tingians* of Ilocos Sur, for whom they still entertain friendship and whom they often visit. They call themselves *Itneg*. A very large proportion of them speak Ilokano, which is not true of the *Kalingas*; and, according to Governor Blas Villamor, who accompanied me on this trip, the language which they use among themselves is, with comparatively minor differences, that of the *Tingians* of Abra. Governor Villamor further states that the costumes which they wear at the present time are practically identical with old *Tingian* ones which have been preserved in Abra for a century and a half. The inaccessibility of the river valley in which the Apayao *Tingians* live doubtless affords a satisfactory explanation of their having retained their primitive dress and customs.

Of this tribe, then, we have a civilized and an uncivilized branch, the people of the former being justly celebrated for their kindness and docility, while those of the latter are equally well known as fierce head-hunters.

On the average, the civilized *Tingians* are perhaps somewhat smaller in size than are the neighboring *Kalingas* and Bontoc *Igorots*. However, the wild *Tingians* of Apayao, of Balbalasan, and of Guinaan are quite

as large as their *Kalinga* and *Igorot* neighbors. One is at once impressed with the fact that the *Tingians* of Abra are somewhat lighter colored than are the people of the other non-Christian tribes of northern Luzon, but this is doubtless in some measure due to their being a scrupulously clean people who bathe with great frequency and thoroughness. Their women are especially well-favored and attractive.

The *Tingian* type of face is very different from that of any other northern Luzon tribe, and many of the men and women have peculiarly sweet expressions, thoroughly in keeping with the mildness and gentleness of their character.

Both the men and women of the more civilized section of the tribe wear the hair uncut, the men confining their long locks at the back of the head by means of handkerchiefs or bits of cloth tied like turbans (Pl. IX, fig. 9), while the women do up theirs nicely with strings of beads, forming knots which are usually at the left sides of their heads. (Pl. XIX, fig. 4.) Among the *Tingians* of Apayao one not infrequently sees men with the hair banged across the forehead after the fashion of the *Kalingas*, but I have never observed the cut over and back of the ear, which completes the *Kalinga* coiffure. (Pl. IX, fig. 8.) The hair is also sometimes ornamented with a wreath of scented grass It is held in place by a more or less elaborate turban which, when possible, is made of bright scarlet and yellow cloth. (Pl. IX, fig. 7.)

Tattooing is practiced to a considerable extent among the *Tingians* of Ilokos Sur and Ilokos Norte and of Abra, and especially among the people of Guinaan and Balatoc, who come in close contact with the Bontoc *Igorots*. Among the people of Apayao elaborate tattoo patterns are rare, if indeed they occur at all. I have never seen one. Most of the men have a large tattoo mark in the form of a cuff on each wrist, sometimes extending down onto the back of the hand. The only tattoo marks I saw on women had been placed over goiters, presumably because they were believed to have therapeutic value.

The typical dress of the *Tingian* men of Abra and of Ilokos Sur and Ilokos Norte is still the clout (Pl. III, fig. 3), although a large percentage of the men have shirts and trousers, which they wear on festival occasions. Nearly all of them wear hats called *salacots*. The typical dress of the women is a neat skirt of white, cotton cloth, with an indigo-blue border. (Pl. XIII, fig. 3.) This cloth is woven by the women themselves. When at work they usually wear no other garment, but most of them have upper garments which are made short-sleeved so as to show their remarkable arm ornaments, and are worn when they are about the house, or at least on feast days and when they have occasion to visit the neighboring, civilized towns. (Pl XIX, fig. 4.) Under the skirt is worn a clout, supported by coils of braided rattan cord, fastened together in such a way as to remain spread over the hips of the wearer, but to constrict readily into a bundle in front and behind, where the

ends of the clout are tied. (Pl. LIX, fig. 2, *a*.) This curious article of dress is decidedly suggestive of the clout, supported by coils of braided rattan cord (Pl. LIX, fig. 2, *b*), which forms the one garment of married women among the mountain *Mangyans* of Mindoro. (Pl. XVI, figs. 1 and 2.)

The men wear few or no ornaments. At the most they have earrings, or armlets or leglets of brass wire. The women have necklaces and strings of beads which they wind into their hair, but their most remarkable and characteristic ornaments are wristlets and armlets of beads which often almost completely cover their wrists and arms to the shoulders. (Pl. XIX, figs. 3 and 4; Pl. XXII, figs. 2 and 3.)

The women consider it a mark of beauty to have the middle of the forearm constricted, and to this end tight armlets of beads are placed about the forearms of little girls and kept there until the pain caused by the constriction of the growing arms becomes unendurable, when other, slightly larger, armlets are substituted. This leads to unsightly swelling of the wrists, which is, however, fashionable. (Pl. XIX, fig. 4; Pl. XXII, fig. 2.)

Old agate beads of considerable value are worn by the women about their necks, and coins are often attached to their necklaces. In 1903, I saw a necklace on which were strung four coins, each more than a century old. (Pl. XIX, fig. 3.)

As one approaches the Bontoc border, the characteristic arm ornaments are less frequently seen, and in Bontoc they are represented, if at all, by a few bands of beads on the wrist and forearm.

The men of Apayao, in addition to a quite elaborately tied clout, wear a short jacket and a turban which is by choice made up of alternating bands of scarlet and bright-yellow cloth. (Pl. III, fig. 4.)

The dress of the Apayao women consists of a piece of cloth wrapped around the body so as to form a short skirt, extending from the waist to the knees. The line of contact of the two ends usually runs straight up and down the front. Under the skirt is worn a clout, and on the upper part of the body a long-sleeved garment which often barely covers the breasts, so that there is quite a gap left between it and the skirt. (Pl. XIII, fig. 4.) The women frequently wear turbans on their heads. They are much more careful than are their sisters of Ilokos and Abra about exposing the upper half of the body. (Pl. XIX, figs. 1 and 2.)

Both men and women of Apayao often wear ornamental wreaths of sweet-scented grass in their hair. (Pl. VII, fig. 1; Pl. IX, fig. 7.) They are very fond of brass wire, which they fasten about their necks or convert into armlets and leglets, but their most highly prized ornament consists of a series of plates and pendants of mother-of-pearl, fastened together with wire or strong thread, in a great mass, which is attached to a cord about the neck and is worn sometimes hanging over the chest

and at other times down the back. This same mother-of-pearl ornament is also worn by men. The women, like their sisters of Abra and Ilokos, are inordinately fond of beads, which they string and wear around their necks, in their hair, and on their wrists and arms. Probably the explanation of their lack of the elaborate armlets worn by the *Tingian* women of Abra may be found in the scarcity of beads from which to make them. Miniature battle-axes are worn thrust into the hair or the turban. They serve a double purpose, as ornaments and as implements for cutting. (Pl. XXII, fig. 4.) Agate beads are more highly valued than are any others.

Occasionally one meets a man whose fingers are covered with gold, silver, and brass rings, or one with very elaborate ear ornaments.

The more civilized *Tingians* build quite compact towns. Their houses are frequently made almost entirely of bamboo and are roomy and scrupulously cleam. (Pl. XXXV, fig. 2.) They are arranged along well-defined streets. (Pl. XXIX, fig. 1.) With the wild *Tingians* of Apayao a large percentage of the houses have floors and sides of boards, hewn with great labor from forest trees. The roofs, which are concave on the inner side, are made with an inner layer of neatly cleaned stems of *runo* grass, tied so closely together that they touch each other. Over this come several inches of thatch and then two or three layers of bamboo, the individual pieces being halved and laid with convex and concave surfaces alternately turned upward. Over the layers of bamboo comes a very thick one of well-packed thatch. A roof of this sort must last for many years, and is perfectly water-tight. The houses of the *Tingians* of Apayao are often framed with hard wood, and many of the boards are ornamented with carvings. (Pl. XXXV, fig. 1.) In some instances eyes, noses, and mouths are cut out of the boards, so that rude effigies of human faces are produced. (Pl. XLVII, fig. 3.) Frequently the side boards are perforated by round peepholes which enable the occupants to observe people outside without exposing themselves.

Houses of the better class are invariably built on piles and raised well above the ground. Some of the poorer houses of the *Tingians* of Apayao are constructed entirely of bamboo, even the roofs being made of joints of this useful plant. In addition to their dwellings, the *Tingians* of Apayao construct rice-granaries (Pl. XXXVI, fig. 3) and chicken-houses. Those of Abra and Ilokos build quite elaborate rice-granaries (Pl. XXXVI, fig. 4) and sometimes construct stables for their domestic animals. They also make miniature houses called *balaua* (Pl. LXVII, fig. 2), in and around which are given feasts in honor of their ancestors.

Although some of the *Tingians* of Abra and Ilokos fish and hunt on occasion (Pl. L, fig. 3), they are essentially an agricultural people and depend for food far more upon the products of their farms than upon those of fishing and the chase. They have extensive rice-paddies on

fairly level ground and also cultivate tobacco, *taro*, Indian corn, and cotton upon a considerable scale. Near their houses they often plant fruit trees. In general it may be said that their agricultural operations are often both more extensive and more successful than are those of their Ilokano neighbors. They raise carabaos, cattle, and horses in considerable numbers. Their horses are used for riding instead of for eating.

So far as my observation goes, the *Tingians* of Apayao have no irrigated rice-fields. They raise a very limited quantity of mountain rice, which, after being threshed, is preserved in joints of bamboo over the fireplaces in their houses. Upon the steep mountain-sides they grow a considerable quantity of tobacco of excellent quality (Pl. XXXIX, fig. 2), and they also raise *camotes*, *gabi*, tomatoes, and squashes. Their *rancherias*, even when high up in the mountains, are almost invariably buried in coconut trees, and each has a group of palms with fan-like leaves from which rain coats are made. (Pl. XXVIII, fig. 2.) Cacao in small quantity, but of fine quality, is usually found growing near their houses.

All the *Tingians* roll their own cigars and make *basi* from sugar-cane juice for use at their feasts and in ceremonials attendant upon the sealing of friendship. The women grind rice between pairs of specially shaped stones. (Pl. LI, fig. 2.)

The *Tingian* women of Abra, Ilokos, and Union spin, dye, and weave cotton, making narrow strips of cloth of excellent quality which they afterwards fashion into garments for themselves. (Pl. XLIV, figs. 1, 2, and 3; Pl. XLV, figs. 1, 2, and 3.) Most of the cloth used by the *Tingians* of Apayao is obviously imported. However, some cloth, evidently made by the women of that region, was seen by me.

Both the civilized and uncivilized branches of the tribe produce very good basket-work. Their houses are well furnished with pottery. Some pieces, decorated with dragons in relief and showing signs of being very old, are probably of Chinese origin. They themselves, however, make good pottery, ornamenting some of it with raised figures.

Many of the *Tingians* are quite skillful in working steel and iron, and the head-axes used by the warlike *Kalingas* are largely made by their more pacific neighbors of Balbalasan. (Pl. XLII, fig. 2.) The *Tingians* of Apayao make their own steel and iron weapons (Pl. XLII, fig. 1) and probably also brass pipes, which are not uncommon among them.

Apart from the house ornaments above referred to, neither the civilized nor uncivilized *Tingians* seem to do much wood carving and neither branch of the tribe does any mining.

The civilized *Tingians* of Abra and Ilokos are the gentlest and most pacific of people. Nearly all of them are entirely unarmed, although most of the settlements can, on a pinch, produce a few rusty head-axes and lances and an old shield or two. The people of the settlements over the

Bontoc border are, as a result of dire necessity, more warlike. They are forced to keep themselves armed and ready to repel *Kalinga* or Bontoc *Igorot* raids. They therefore carry head-axes, lances, and shields. (Pl. XI, fig. 3.) Their shields and lances are similar to those used by the Bontoc *Igorots* (Pl. LXI, figs. 1, *e* and 2, *e*; Pl. LX, figs. 2, *n* and *o*) and their head-axes to those used by the *Kalingas*. (Pl. LX, fig. 1, *e*.)

The more civilised *Tingians* of Abra, Ilkoos, and Union have not taken heads for many years. However, those of Guinaan, Balatoc, and Balbalasan have, until quite recently, been head-hunters, and those of Apayao are still devoted to this form of sport. The latter section of the tribe uses lances with long, slender blades (Pl. LX, fig. 2, *n*), head-axes of peculiar form (Pl. LX, fig. 1, *f*; Pl. LI, fig. 4), and shields each of which consists of a rectangular board with a spine of wood projecting from the center of each end. The body of the shield is black, and on this are painted ornamental geometric designs in red and yellow. (Pl. LXI, figs. 1, *f* and 2, *f*.)

Scattered through the towns of the more civilized *Tingians* are to be found numerous miniature houses in which are put food and other offerings for the *anitos* or spirits, and beside the trails leading into the towns may often be seen pieces of bamboo with their lower ends sharpened and driven into the ground, and their upper ends split into a dozen slats, which are held apart by other bamboo slats, horizontally interwoven with them in such a way as to form small baskets. (Pl. LXVII, fig. 1.) In these are placed plates of boiled rice, chicken-livers, etc., as offerings to the spirits or *anitos*.

The warlike *Tingians* of Apayao also exhibit in these baskets the heads of their victims; eight heads were so displayed at the *rancheria* of Nagsimbangan at the time of our visit to it. During my short stay in Apayao I was unable to gather any reliable information relative to the customs and ceremonies connected with the head-hunting of the men of that region.

The musical instruments of the more civilized *Tingians* are the *gansa*, which is played with the hands (Pl. LVII, fig. 3), the bamboo mouth-organ (Pl. LVII, fig. 1), and the nose-flute of bamboo. The operator of the latter instrument plugs up one nostril with a mass of soft vegetable fiber, and blows the flute with the other (Pl. LVII, fig. 2); or he may press the flute against the nose in such a way as to close one nostril while he blows through the other.

The *Tingians* of Apayao make musical instruments of bamboo which, for the lack of a better name, may be called "jew's-harps." A single joint of *caña bojo* is taken, one end is cut off, and more than half of one side cut away so as to leave a projecting tongue. Near the septum at the end of the joint a round hole is pierced, over which the thumb of the operator may be placed. The projecting tongue is then struck upon the head of a battle-axe and the musical tone produced by the resulting

vibration can be varied by thumbing the hole pierced near the septum. The men often play these instruments when on the march.

The dances of the civilized *Tingians* take place inside a typical *cañao* circle and are usually participated in by one man and one woman, although if the man is an especially noted dancer, two or more women may honor him by entering the circle and showing off their fancy steps. Both men and women dance with handkerchiefs or larger pieces of cloth stretched between their hands. (Pl. LVIII, fig. 1.) The dance music is furnished by *gansas* alone and is of a decidedly lively character, as are the dances themselves. The participants often evidently try to dance each other down, and the exercise involved is so vigorous that one or another of them is sure soon to give out. When a dancer has had enough, he or she indicates the fact by giving a sharp snap to the piece of cloth held in the hands and then immediately retires. If a man is danced down by a woman, he is jeered by the crowd. *Basi* circulates freely during the dancing. In fact, the *Tingians* will not attempt to give a dance unless *basi* is to be had in abundance. The dancers often add to their performances by composing extemporaneous songs dealing with important current events, and they are frequently answered in song by some of the spectators.

I was unfortunate in failing to see dances among the *Tingians* of Apayao, but was told that they were similar to those of the people of Abra. However, I did see *gansas* and nose flutes among them, and was surprised to run across a long, wooden drum similar in shape to those used by the Benguet-Lepanto *Igorots*.

The civilized *Tingians* are polygamous. The headmen may have two or three wives, but this privilege seems to be quite strictly confined to them. The men not infrequently keep *queridas*, but very secretly, for if the facts became known, their wives may secure divorce from them and compel them to pay heavy fines into the bargain.

Betrothals are arranged by parents between very young children. In fact, in some instances, they are arranged prior to the birth of a child, of course with the proper proviso as to its proving to be of the right sex. The marriage ceremony among the *Tingians* of Abra is interesting. After the preliminaries have been arranged between the families of the bride and bridegroom the family of the bride invites that of the bridegroom to come for her on a certain fixed date. The latter arm themselves with bolos on the evening of the day before the one set and at midnight feign an attack upon the house of the bride. The bridegroom is the only person to enter the house. He leads the bride out by the hand, releasing her at the bottom of the stairway. She accompanies him to his house. On the next day her family follows her and a feast begins which usually lasts for about four days, at the end of which time the relatives of the bridegroom kill animals and distribute the flesh liberally to the guests in order that, in their desire to carry it home, they may go

Anniversaries of the deaths of adult persons are celebrated annually, by feasts held in and about the *balauas.*

The civilized *Tingians* know their own ages, differing in this respect from the people of any other non-Christian tribe of northern Luzon. In reckoning time they have weeks of seven days each, and months of which there are eleven to the year. Their year begins during our month of January, when the moon is a quarter full.

The *Tingians* of Abra have advanced further in civilization than have the members of any other non-Christian tribe of the Philippines. They are a most attractive people, cleanly in their personal habits, and of excellent disposition. They are peaceable and law abiding to an astonishing degree. Crime is almost unknown among them. Their towns are well built and well kept. Their fields are often better tilled than are those of their Ilokano neighbors. They save their money and some of them become quite wealthy. They are anxious to receive the benefits of civilization now that they may have them without being compelled to change their religious belief, and there is hardly a *rancheria* in Abra which does not have one or more schoolmasters, paid by local revenues or by voluntary contributions. Considerable numbers of *Tingian* children attend the public schools in the Christian municipalities in spite of the hostility which exists between their people and the Ilokanos.

The *rancherias* of Abra and of North and South Ilokos have been given independent governments of their own, which have progressed very satisfactorily. The *Tingian* is a born politician and thoroughly appreciates being allowed to run his own local affairs.

While there have long been bloody feuds between the *Tingians* of Apayao and their civilized neighbors, the fault is by no means all with the wild people, and when order is once established throughout their territory there is no reason why they should not advance rapidly in civilization and in material prosperity, for they too are cleanly, intelligent, and industrious. The degree of civilization to which they have already attained is surprising when one remembers that they have been almost completely shut off from the outside world from the date of the discovery of the Philippines up to the present time.

A careful study of this section of the tribe would doubtless be well repaid and would throw much light on the early history of the *Tingians* of Abra and Ilokos, from whom the Apayao people are, according to their own traditions, descended.

THE ISINAYS, GADDANES, AND REMONTADOS.

The inhabitants of southern Nueva Vizcaya, at the time when the Spaniards first entered the territory now embraced in that province, were called *Isinays* (*Isnays, Isinac, Isinayas*). Nearly all of them were subsequently converted to Christianity, but on the eastern slopes of the mountains which separate southern Nueva Vizcaya from Benguet and

along the Padre Juan Villaverde trail there still remain a few wild people called *Isinays*. I have never seen them. Dr. Barrows states that they resemble the Benguet-Lepanto *Igorots* more than the *Ifugaos*, and Governor Knight of Nueva Vizcaya says that they are very similar to the former people. It is not easy to decide whether or not they originally belonged to the same tribe and represent only a dialect group, but pending further information relative to them I shall so treat them.

Many of the civilized inhabitants of Isabela and of Cagayan are descended from a people who were called *Gaddanes*, and this name is still sometimes used as a designation for the long-haired, wild people of these two provinces. I do not believe that the *Gaddanes* were at any time more than a dialect group of the *Kalingas*.

Dr. Barrows has treated the so-called *Remontados* as if they constituted a separate tribe. This is not the case. It is very generally true that there will be found in the vicinity of non-Christian tribes in these Islands renegade Christian natives who have abandoned civilized life and taken to the hills. Not infrequently they marry women of the hill tribes and have half-caste children, but I see no more fitness in assigning to such people and their offspring the rank of a tribe than there would be in following the same course with reference to the people of mixed blood who are usually to be found in greater or smaller numbers wherever two non-Christian tribes adjoin each other.

DIALECT GROUPS.

As I have already stated, it seems to me far wiser to class peoples which are substantially alike except for differences of dialect in one tribe and to divide them into dialect groups rather than to attempt to make as many tribes as there are dialects spoken.

Were we to adopt the other basis it would lead us into manifest absurdity in classifying the civilized tribes. While the *Ilokanos* of North Ilokos, South Ilokos, Union, and Abra can understand each other after a fashion, Governor Villamor, himself an Ilokano, assures me that there are very great differences in their dialects. This holds to even a greater extent among the Visayans, yet no ethnologist thinks of dividing them into *Ilongos, Cebuanos, Cuyunos*, etc.

A considerable amount of new work must be done before a satisfactory conclusion can be reached as to the dialect groups into which the seven tribes of northern Luzon should be divided.

The *Negritos* have very generally adopted the language of their civilized neighbors. This can hardly hold for the *Negritos* of eastern Cagayan and Isabela, who, on account of the extent of the territory which they occupy and their comparative isolation, must, it would seem, have a language of their own; but of these people we know next to nothing at the present time. I saw about one hundred of them at Dumabato in 1905 but had little opportunity to study them.

So far as we at present know, the *Ilongotes* have but a single dialect, but it is probable that those of northern Tayabas speak a different dialect from those of Nueva Vizcaya.

The *Ifugaos* should be divided into numerous dialect groups.

In the absence of Lietuenant Case, who has lived among them for years, I have no information to add to that gathered by Dr. Barrows and therefore provisionally adopt his conclusions as to the number of such groups which should be recognized.

As yet we know very little as to the language of the *Kalingas.* The people known as *Dudayags* and *Calauas* are said to have peculiar dialects, as are also the *Catalanganes.*

I have not sufficient information relative to the dialects spoken by the Bontoc *Igorots* to be able to form any conclusions as to the subdivisions of this tribe.

The two important dialects of the Benguet-Lepanto *Igorots* are *Nabaloi,* spoken in central and southern Benguet, and *Kankanai,* spoken in eastern and northern Benguet, in Amburayan, and in southern Lepanto. There is, it is said, another dialect called *Kataugnan,* spoken by the *Igorots* of central and northern Lepanto.

So far as concerns the *Tingians,* it may prove that the people of Apayao form a dialect group and that those in the region of Guinaan, Balatoc, and Balbalasan can be differentiated on account of peculiarities of speech, but more work needs to be done before definite and satisfactory conclusions on this subject can be reached.

ORIGIN OF THE NON-CHRISTIAN TRIBES OF NORTHERN LUZON.

I agree with the conclusion reached by Dr. Barrows that the only races to which we need give consideration in accounting for the origin of the tribes under discussion are the *Negrito* race and the *Malay* race. Possibly an exception should be made in the case of the *Kalingas,* many of whom have eyes which are decidedly suggestive of Chinese or Japanese origin, but there is no direct evidence that central or northern Luzon has ever been occupied by Chinese in large numbers, and if such occupation really occurred, a study of the language of the *Kalingas* should show affinities with Chinese.

The *Ibilaos* are the only northern Luzon people who have intermarried extensively with the *Negritos,* and in my opinion the influence of *Negrito* blood may be left out of account in considering the origin of the other tribes.

The *Tingians* differ physically in important particulars from the other northern Luzon tribes and seem to have much in common with the *Mangyans* of Mindoro and the *Dyaks* of Borneo, but there is no evidence that they have had other than a Malay origin.

ILLUSTRATIONS.

PLATE VI:

Fig. 1. A Bontoc *Igorot* man of Bontoc, Bontoc. Note the woven rattan cap ornamented with dog's teeth and with a piece of mother-of-pearl; also the metal tobacco-pipe and pipe-cleaner.

Fig. 2. A Bontoc *Igorot* man of Bontoc, Bontoc, showing physical characteristics. Note the plug of wood in the ear.

Fig. 3. A young Benguet-Lepanto *Igorot* man of Bua, Benguet, showing physical characteristics. Note the short-cut hair and the turban.

Fig. 4. Chapdai, an old Benguet-Lepanto *Igorot* priest of Bua, Benguet, showing physical characteristics.

PLATE VII:

Fig. 1. A wild *Tingian* man of Aoan, district of Apayao, Cagayan, showing physical characteristics and dress.

Fig. 2. A typical *Tingian* man of Manobo, Abra, showing physical characteristics.

Fig. 3. An *Ilongot* man of Dumabato, Isabela. Note the long hair, tied up, the peculiar hair ornaments, the ornament fastened to the cartilage of the upper ear, the fine, braided cord worn over the right shoulder and under the left arm, and the tobacco pouch of bark cloth ornamented with seeds hanging down the back.

Fig. 4. A young *Kalinga* man of the settlement of Bontoc, Cagayan (this settlement should not be confused with the settlement of Bontoc in the sub-province of the same name). Note the plugs of wood in the lobes of the ears, the bead collar, and the buttons sewed on the neck of the jacket as ornaments; also the bag hanging about the neck, which is opened and closed by sliding metal rings, the silk blanket knotted over the right shoulder, and the head-axe.

PLATE VIII:

Fig. 1. The *Kalinga* chief of a settlement on the Rio Grande de Cagayan, near Ilagan, Isabela. Note the hair ornaments of feathers, beads, and mother-of-pearl; also the jacket of *Kalinga*-made cloth ornamented with beads.

Fig. 2. A young *Ifugao* man of Quiangan, Nueva Vizcaya. Note the huge metal ear-ornaments and the girdle of opercula.

Fig. 3. An *Ifugao* man of Quiangan, Nueva Vizcaya, showing typical tattoo pattern.

Fig. 4. A Bontoc *Igorot* man of Labuagan, Bontoc, showing typical tattoo pattern.

PLATE IX:

Views showing typical methods of cutting and dressing the hair in vogue among the men of the several non-Christian tribes of northern Luzon.

Fig. 1. *Negrito* of Mariveles with hair cut short and crown of head shaved.

Fig. 2. An *Ilongot* of Delapping, Nueva Vizcaya, hair uncut and confined in front by a net peculiar to the men of this tribe.

Fig. 3. A *Kalinga* of Cagayan. Note the high cheek bone.

Fig. 4. An *Ifugao* of Quiangan, Nueva Vizcaya.

Fig. 5. A Bontoc *Igorot* of Bontoc, Bontoc, showing typical hair-cut and ornamental, woven rattan cap on which are fastened a piece of mother-of-pearl and two dog's teeth.

Fig. 6. A Benguet-Lepanto *Igorot* of Ambuklao, Benguet.

Fig. 7. A wild *Tingian* man of Aoan, Apayao district, Cagayan, showing the hair confined by a tasseled turban and ornamented with a wreath of fragrant grass.

Fig. 8. A wild *Tingian* man of Aoan, Apayao district, Cagayan, showing typical fashion of wearing the hair.

Fig. 9. A civilized *Tingian* of Manobo, Abra.

PLATE X:

Fig. 1. A *Negrito* man of Mount Mariveles, Bataan. Note the boar's-bristle ornaments on his legs.

Fig. 2. An *Ilongot* man of Canadem, Nueva Vizcaya, holding a hunting lance and a bow and arrows.

Fig. 3. A *Kalinga* warrior of Bunuan, Cagayan. Note the shield and head axe, the silk blanket, the bead collar, and the bag worn about the neck which is closed with sliding silver rings.

PLATE XI:

Fig. 1. A fully armed *Ifugao* warrior of Banaue, Nueva Vizcaya. He carries a typical *Ifugao* shield, head-knife, and lance.

Fig. 2. A fully armed Bontoc *Igorot* warrior of the *rancheria* of Bontoc. Note the three-barbed lance, the shield, and the head-axe.

Fig. 3. Atumpa, the *Tingian* chief of Guinaan. Note his feather head ornaments and typical lance, head-axe, and shield.

PLATE XII:

Fig. 1. A typical *Negrito* woman of Dumabato, Isabela, with two children, showing typical dress. Note the skirt of bark cloth.

Fig. 2. An *Ilongot* woman of Canadem, Nueva Vizcaya, showing typical dress. Note the shell girdle and the fold of the skirt which serves as a pocket.

Fig. 3. A young *Kalinga* woman of a settlement on the Rio Grande de Cagayan near Isabela, showing typical dress. The jacket and skirt are of *Kalinga* weave.

Fig. 4. An *Ifugao* woman of Quiangan, Nueva Vizcaya, showing typical dress.

PLATE XIII:

Fig. 1. A Bontoc *Igorot* woman of the settlement of Bontoc, showing physical characteristics and typical dress.

Fig. 2. A Benguet Lepanto *Igorot* woman of Baguio, Benguet, showing dress of the women of the better class. Note the numerous superimposed skirts; also the metal ornaments suspended from the chain about the neck.

Fig. 3. A young *Tingian* woman of Lanao, Abra, showing dress and ornaments.

Fig. 4. A wild *Tingian* woman of Masimut, district of Apayao, Cagayan, showing dress and method of carrying young child.

PLATE XIV:

Fig. 1. A young *Ifugao* warrior of Quiangan, Nueva Vizcaya, showing typical dress and ornaments. Note the girdle of opercula, the ear ornaments, the lance, and the rattan carrying basket which serves also as a raincoat.

Fig. 2. An *Ifugao* family of Banaue, Nueva Vizcaya, showing typical dress and manner of carrying young children. Note the white cock's feathers in the woman's hair.

Fig. 3. Two *Negrito* women, Zambales, showing typical dress. Note especially the peculiar hair-cut of the woman at the left.

PLATE XV:

Fig. 1. A typical *Tingian* woman of Guinaan, Bontoc, showing peculiarly shaped clout-supporter made of braided rattan cord.

Fig. 2. A *Mangyan* woman of the Baco River country, Mindoro, showing typical dress. The original costume of the *Tingian* women may have been similar to that of the *Mangyan* women, the skirt having been added later. Many of the *Mangyan* women on the Baco River are beginning to adopt skirts, which they wear over their clouts.

Figs. 3 and 4. *Ilongot* arrows, two of which have detachable heads fastened with cord to their shafts. Delapping, Nueva Vizcaya.

PLATE LI:

Fig. 1. A Benguet-Lepanto *Igorot* woman on horseback, Tublay, Benguet.

Fig. 2. A *Tingian* woman grinding rice between stones, Salapadan, Abra.

Fig. 3. A Benguet-Lepanto *Igorot* man mounting a horse, Pico, Benguet.

Fig. 4. Three styles of head-axe in use among the wild *Tingians* of Masimut, district of Apayao, Cagayan.

Fig. 5. Back view of an *Ifugao* shield, Banaue, Nueva Vizcaya.

PLATE LII:

Fig. 1. *Negrito* circle dance, Zambales.

Fig. 2. *Negrito* circle dance, Mount Mariveles, Bataan.

Fig. 3. *Negritos* of Zambales doing buck and wing dance.

Fig. 4. *Negritos* of Mount Mariveles, Bataan, playing *gansas* and at the same time dancing on their knees.

PLATE LIII:

Fig. 1. *Ilongots* playing bamboo musical instruments, Delapping, Nueva Vizcaya.

Fig. 2. An *Ilongot* executing a war-dance to the tune of a bamboo musical instrument, Delapping, Nueva Vizcaya.

PLATE LIV:

Fig. 1. A typical *Ifugao* dance, Quiangan, Nueva Vizcaya.

Fig. 2. A Bontoc *Igorot* head-dance, settlement of Bontoc. The man at the extreme right who holds a head-axe in his right hand is the principal actor. Note that the women who are dancing all wear blankets.

PLATE LV:

Fig. 1. Two Bontoc *Igorot gansa* players. Note their drumsticks, also the handles of their *gansas* consisting in each case of a human lower jaw; settlement of Bontoc.

Fig. 2. Bontoc *Igorot* funeral dance, executed at Manila by people from the settlement of Bontoc.

PLATE LVI:

Fig. 1. Musical instruments of Benguet-Lepanto *Igorots* consisting of a wooden drum with skin head; a *gansa* with boar-tusk handle and a wooden stick for use in playing the *gansa*.

Fig. 2. Benguet-Lepanto *Igorot* musicians. The jar at the left contains *tapuy*, a fermented drink made from rice with which both musicians and dancers frequently refresh themselves.

Fig. 3. A typical Benguet Lepanto *Igorot* dance. Note the woman with the palms of her hands turned forward and the man with the blankets over his shoulders.

PLATE LVII:

Fig. 1. A *Tingian* woman of Balbalasan playing a bamboo mouth organ.

Fig. 2. A *Tingian* man of Manobo, Abra, playing a nose-flute.

Fig. 3. *Tingian gansa* players of Balbalasan. The *gansas*, the handles of which are hooked into the belts of the men's clouts, are beaten with their hands.

PLATE LVIII:

Fig. 1. A *Tingian* dance, Padangita, Abra. Note the feather ornaments on the heads of the dancers and the blankets in their hands. When one of the dancers wishes to stop dancing, that fact is indicated by giving the blanket a sharp snap.

Fig. 2. *Kalingas* of Tooktook, Cagayan, taking a raft down a dangerous rapid of the Mabaca River.

constantly played by the women when on the trail during certain months of the year.

Fig. 1, *d* and *e*. Bamboo flutes of Benguet-Lepanto *Igorots*.

Fig. 1, *f*. Bamboo jew's-harp of Benguet-Lepanto *Igorots*. An entirely similar instrument is used by the Bontoc *Igorots*.

Fig. 1, *g*. An *Ifugao* carved, bamboo lime-box, Banaue, Nueva Vizcaya.

Fig. 2, *a*. Clout supporters of braided rattan worn by *Tingian* women of Abra, North and South Ilokos and Bontoc.

Fig. 2, *b*. Clout supporters, of braided rattan and plain rattan respectively, worn by *Mangyan* women of the Baco River, Mindoro.

PLATE LX:

Fig. 1, *a*. *Ilongot* head-knife and scabbard, Oyao, Nueva Vizcaya.

Fig. 1, *b*. *Kalinga* head-axe.

Fig. 1, *c*. *Ifugao* head-knife and scabbard, Mayoyao, Isabela.

Fig. 1, *d*. Bontoc *Igorot* head-axe, settlement of Bontoc.

Fig. 1, *e*. *Tingian* head-axe, Guinaan, Bontoc.

Fig. 1, *f*. Head-axe of type used by wild *Tingians* of the Apayao district, Cagayan.

Fig. 2, *a*. *Ilongot* lance, Dumabato, Isabela.

Fig. 2, *b*, *c*, *d*, *e*, and *f*. *Kalinga* lances, Isabela. Note the shafts which are ornamented with highly colored, woven rattan and with horsehair. Note also the different forms of head. That shown in Fig. 2, *f* is of bamboo.

Fig. 2, *g*, *h*, and *i* *Ifugao* lances, Nueva Vizcaya. The steel heads of these lances were made at Sapao.

Fig. 2, *j*, *k*, *l*, and *m*. Bontoc *Igorot* lances, showing different styles of head; settlement of Bontoc.

Fig. 2, *n*. Lance of a wild *Tingian* of Masimut, district of Apayao, Cagayan

Fig. 2, *o*. Lance of a wild *Tingian*, northern Bontoc.

PLATE LXI:

Fig. 1. Front views of typical shields belonging to the following tribes: *a*, *Ilongots*; *b*, *Kalingas*; *c*, Bontoc *Igorots*; *d*, Benguet Lepanto *Igorots*: *e*, *Tingians* of Guinaan, Bontoc; *f*, *Tingians* of district of Apayao, Cagayan.

Fig. 2. Back views of shields shown in fig. 1.

PLATE LXII:

Fig. 1. Entrance to a *Kalinga* house of Bunuan, Cagayan, showing bloody emblems over the door Each piece of bark cloth with a blood stain on it indicates that the owner of the house has participated in a headhunt during which one or more of his companions took heads. Bark cloth, dipped in the blood of such a head and hung over the door, is supposed to avert the vengeance of the friends of the beheaded warrior and to keep off illness.

Fig. 2. An old *Ifugao* warrior of Quiangan, Nueva Vizcaya, with a part of his collection of enemies' skulls.

PLATE LXIII:

Fig 1. Entrance to an *Ifugao* house of Banaue, Nueva Vizcaya, showing *anito* door posts, and skulls of enemies beheaded by the owner of the house.

Fig. 2. A beheaded *Ifugao* warrior being carried out on his shield for burial, Banaue, Nueva Vizcaya.

two bamboos projecting upward are part of the stretcher on which the body was carried. It has been interred in a tunnel leading into the hillside and the stretcher stands vertically against the end of the tunnel. Note the steep mountains in the background. They form typical *Ifugao* country. War-trails lead along their treeless ridges and cultivated fields in many instances extend to their very crests.

Fig. 2. Public buildings of an *áto* of Bontoc *Igorots*, Talubin, Bontoc. Note the dead tree with sharpened branches on which heads may be placed while the head-feast is celebrated. The stone court of the *pabafúnan* was occupied by the *áto* council at the moment the picture was taken.

Fig. 3. A basket of skulls from a Bontoc Igorot *fáwi*, settlement of Bontoc.

PLATE LXV:

Fig. 1. An *Ifugao* burial house, Banaue, Nueva Vizcaya.

Fig. 2. The grave of an impecunious *Tingian* man, Balbalasan, Bontoc.

PLATE LXVI:

Fig. 1. Burial place of Benguet-Lepanto *Igorots*, Baguio, Benguet. Note the wooden coffin carved in rude imitation of a carabao.

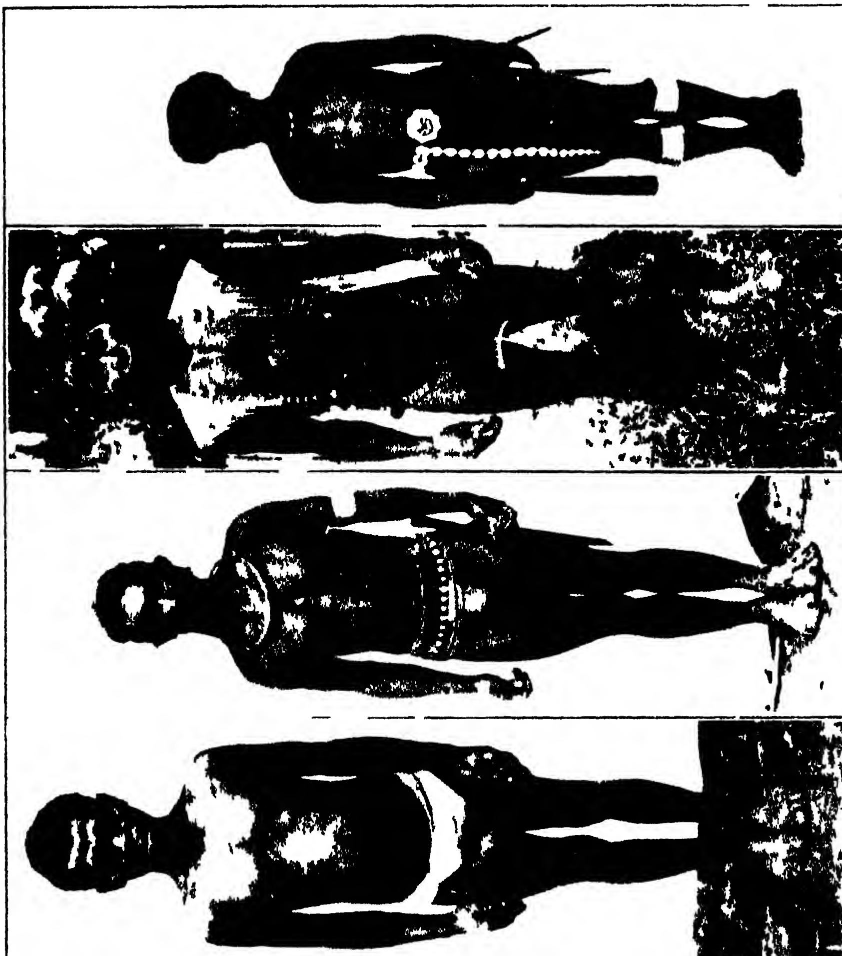
Fig. 2. *Tingian* mother mourning over her dead daughter, Ablug, Bontoc. Note the ornaments worn by the daughter. They were doubtless buried with her.

PLATE LXVII:

Fig. 1. Small structure of the sort in which the civilized *Tingians* place offerings for the *anitos*. Such little buildings are numerous about the outskirts of the civilized *Tingian* towns. Note the two conical, bamboo baskets at the left of this structure. Offerings are also placed in these baskets.

Fig. 2. A *Tingian balawa*, or house in which annual festivities are held in honor of deceased relatives. After the death of an adult person the head of the family is obliged to sleep in the *balawa* for three to five months during which period he may not enter his own house; Daguioman, Abra.

PLATE I



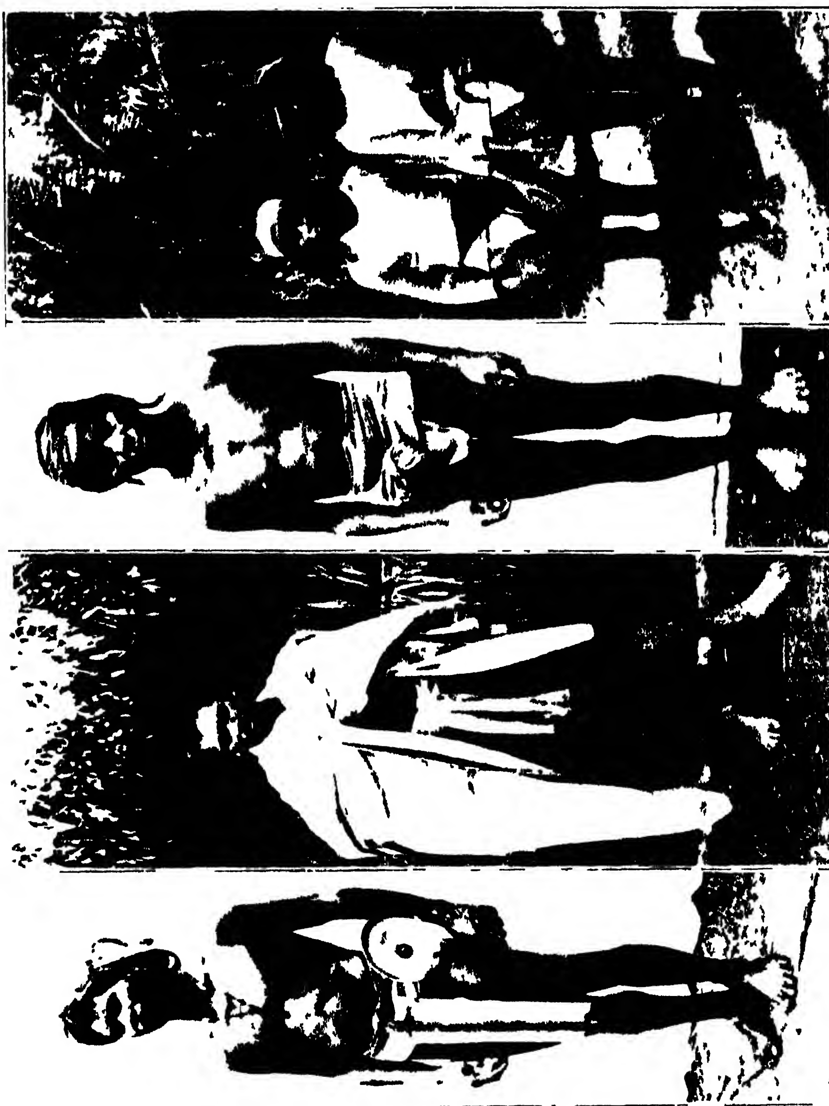


PLATE V


3

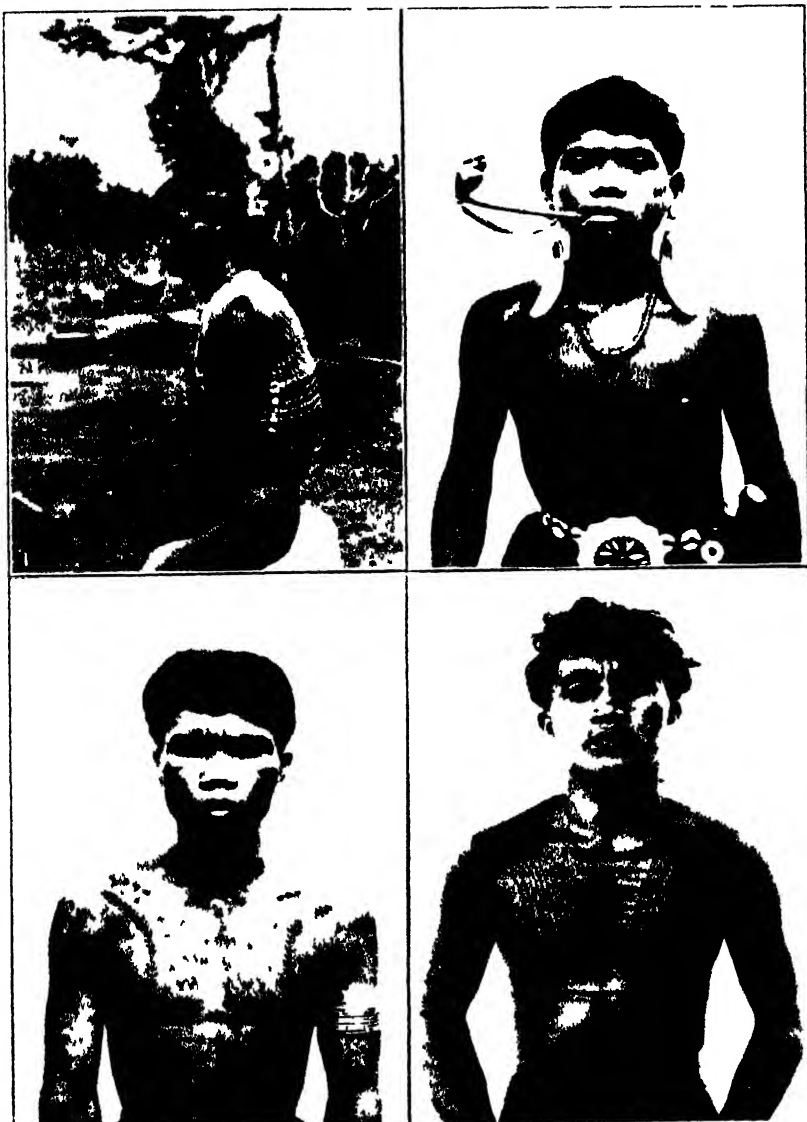
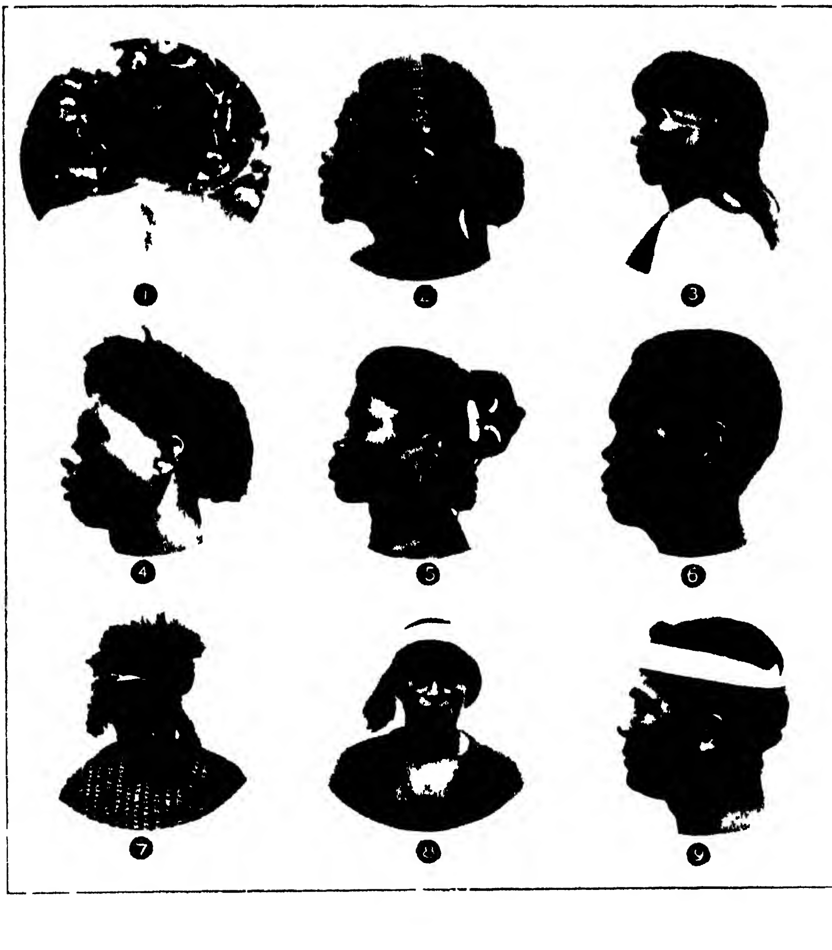


PLATE V


1
2
3
4
5
6
7
8
9

LATE XV

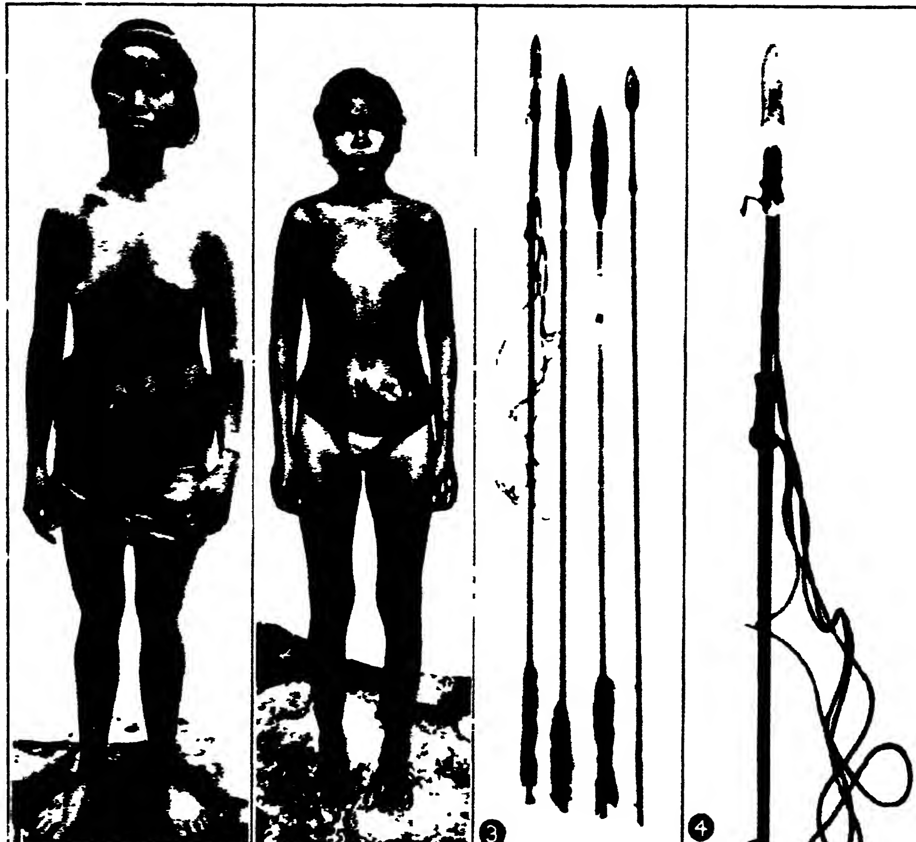

1
2
3
4

PLATE XXI


3

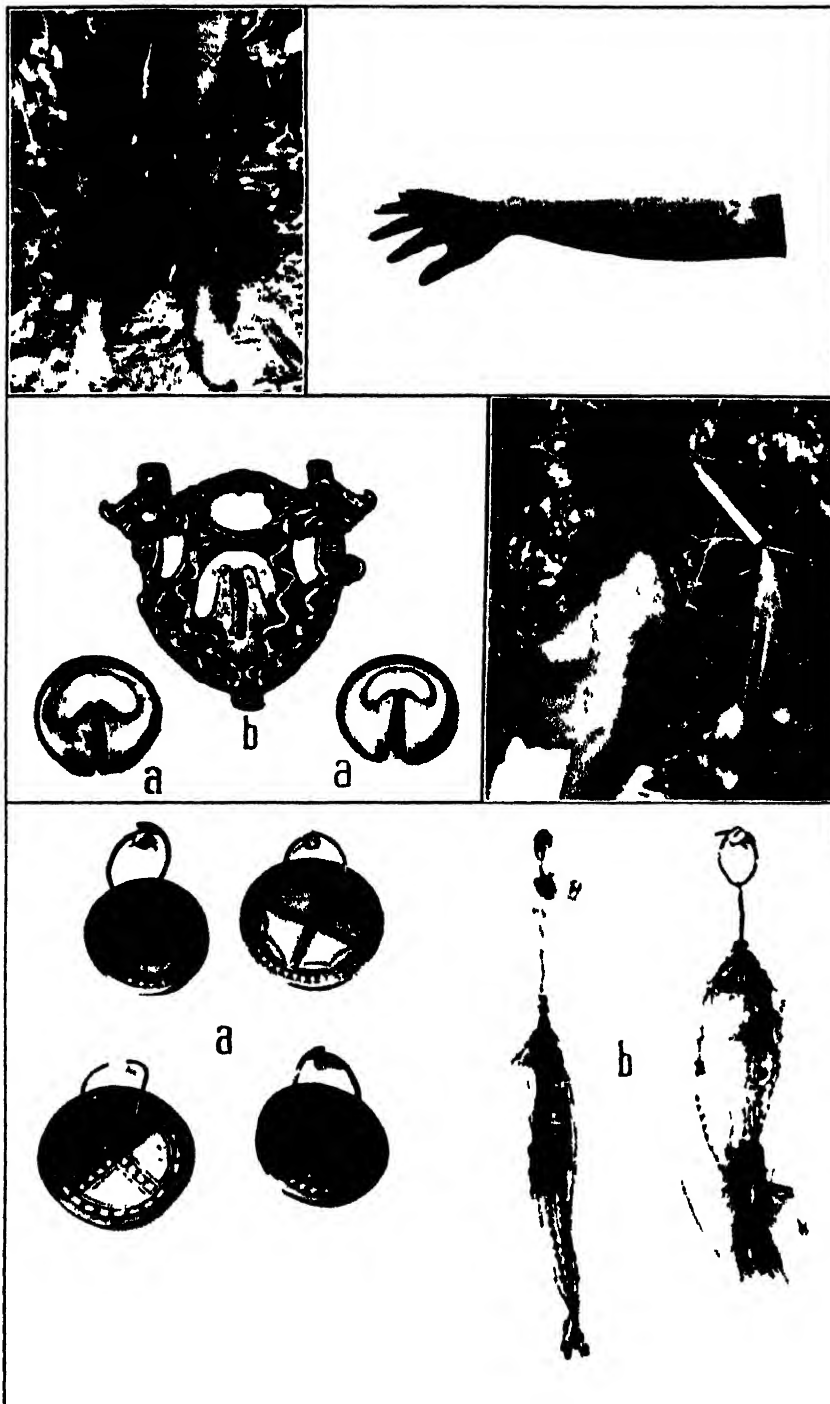


PLATE XXV.

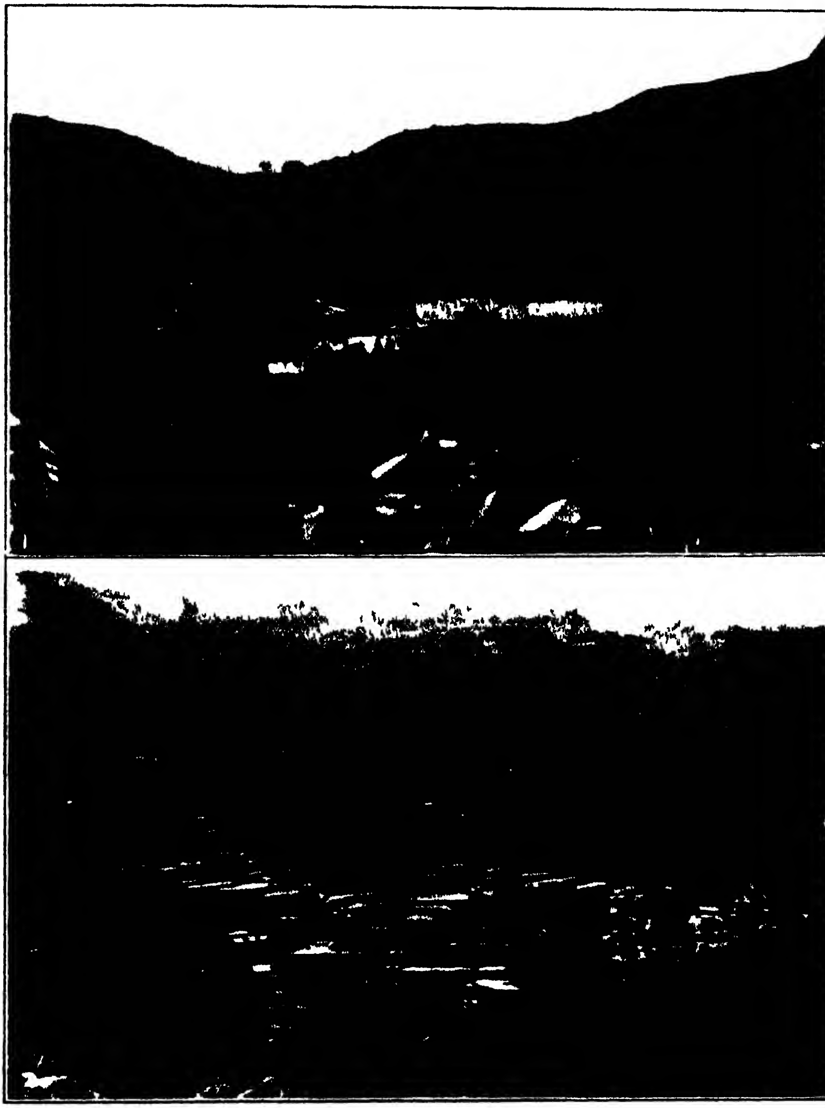


PLATE XXVII

PLATE XXX.

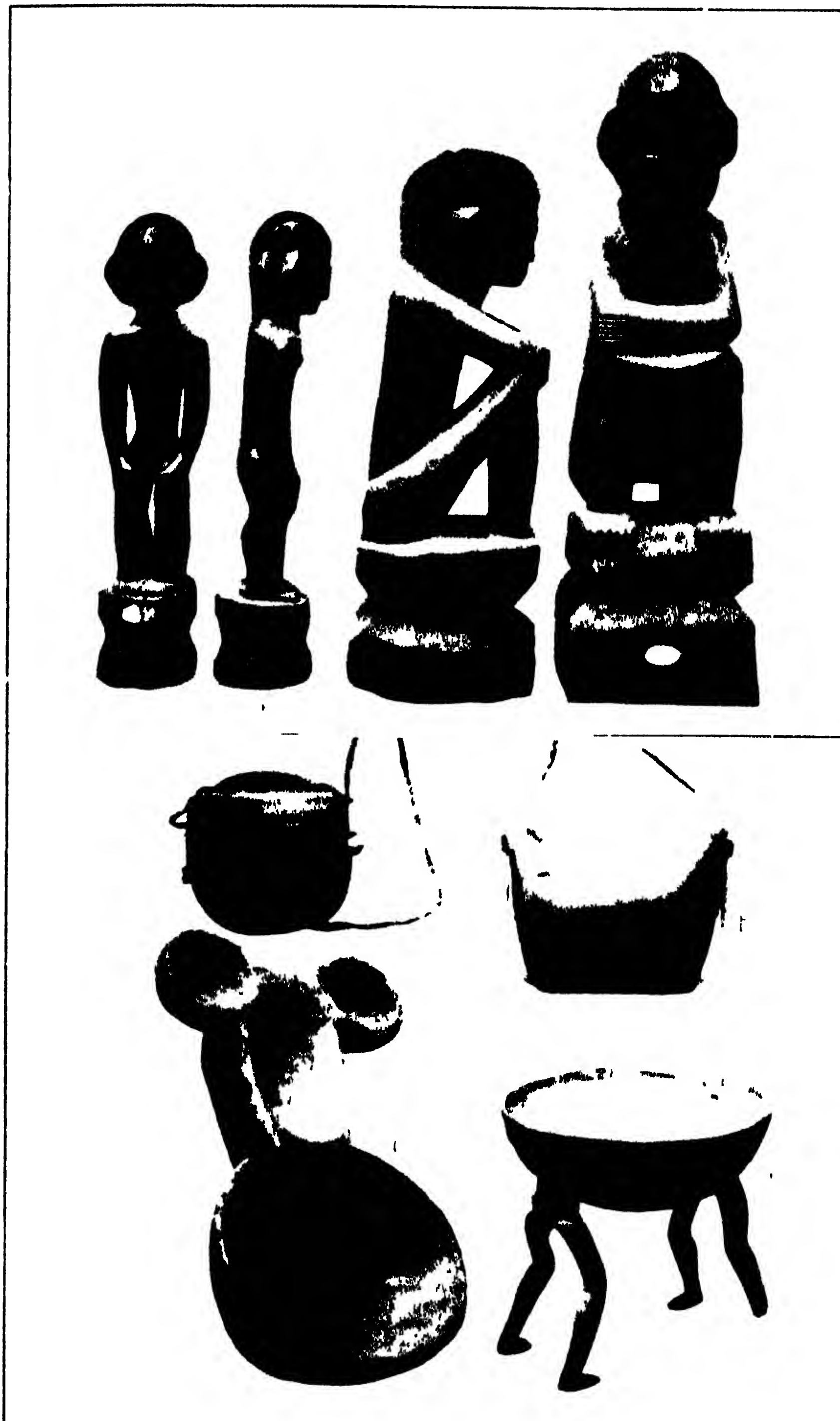


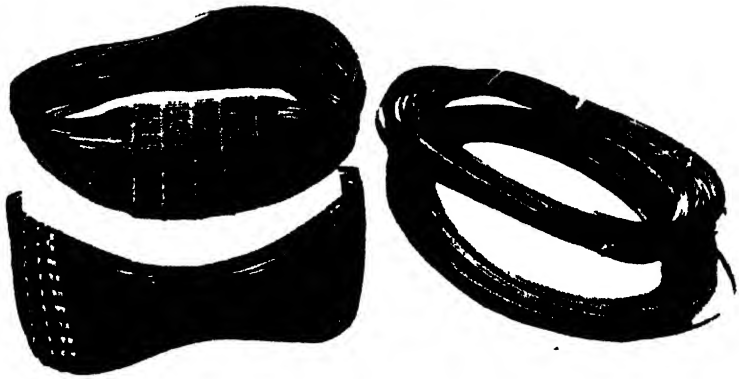
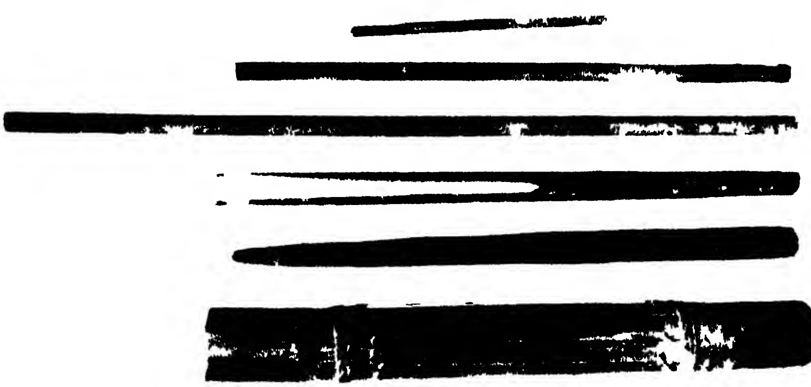
PLATE XLIX

[redacted]

[redacted]

PLATE

PLATE LVII

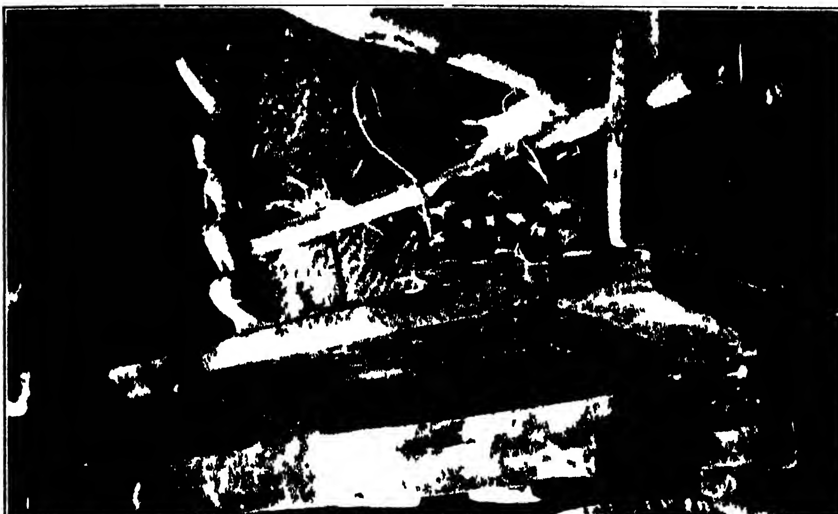


PLATE LXV

PLATE LXV

PHILIPPINE COALS AND THEIR GAS-PRODUCING POWER.

By Alvin J. Cox.

(*From the Chemical Division, Bureau of Science.*)

Although coal occurs so abundantly in the Philippines, native coal is used only sparingly as a fuel. It has been employed on the small vessels plying along the coast with fairly satisfactory results, but, largely owing to the undeveloped condition of the mines and the difficulty of transportation, it has come very little into competition with the coal imported from Japan and Australia.

The Philippine coals are deposits of the so-called black lignites but are superior to ordinary lignite in every respect. It is rather the exception for these coals to have a brownish color and they never show a woody structure. In appearance they are usually black and shiny, much resembling bituminous coal, but have a slightly lower calorific value than the latter. On the other hand, they have a much higher calorific value than ordinary brown lignite.

A great many formulæ which have been found to approximate the truth have been proposed [1] for the calculation of the total amount of heat obtainable on the combustion of coals, from their ultimate analyses. Dulong's formula is said to give results with a probable error not exceeding 2 per cent—that is, they differ by not more than 2 per cent from the value obtained by experiment in the bomb calorimeter.

Fewer attempts have been made to derive a formula for the calculation of the calorific value of coals from their proximate analyses. In 1896 Goutal [2] deduced a formula from the calorific determinations of some 600 coals of different kinds, by which the results of calculation in nearly every case agree within 1 per cent with those of experiment. Gill [3] says that the results upon a series of American coals varied less than 2 per cent from those obtained by the calorimeter. Such a formula is

[1] Formulæ of Dulong, Gmelin, Cornut, Ser, Scheurer-Kestner and Meunier Dollfus, *Ann. Chim. Phys.* (1886) (6), **8**, 267; and Bunte, *J. f. Gasbeleuchtung*, **34**, 21–26 and 41–47.

[2] *Rev. d. Chim. ind.* (1896) 7, 65.; *Compt. rend. Acad. d. sc.*, Par. (1902) (12), **135**, 477–479.

[3] Gill, A. H.: Gas and Fuel Analysis for Engineers, New York (1902), p. 90.

TABLE I.—*Outcrop and upper-bed coals of Batan Islan l.*

No	Laboratory ind	sture.	olatil stib	Fl cal		olor of ash.	Tc			gravity.	Calcul caloric	100 V.C.[a] / V.C.+F.C.	ratio.
	3908	6.08	40.36	51.21		Yellowish brown.	4 00			1.30	6,775	44.1	1.270
2	227	5.00	42.21	49.70	3.08		0.22	0 05	0.52		6,095	45.9	1.178
3	3907	7.40	40 84	48.06	3.70	Light gray	1 62			1.:	6,470	45.9	1.177
4	1688	9 4	38.5	43 8	8 3					1 37	5,915	46 7	1,137
5	1637	6.90	36.9	40.0	16 20	----					5,456	48	1.085
6	2396	5 80	41.2	44 5	8.5						6,080	48.1	1.080
7	3908	9 53	41 56	44 86	4 05	Brown --	2 37			1.30	6,125	48.1	1.078
8	2397	6.00	42.2	44 0	7 8		0.49				6,080	49	1.044
9	3908	5 10	38.28	39.84		Light brown	1 11	-------	----	1.34	5,506	49	1.042
10	4086	20 80	37	37 4	4 9	- ------ --	1.13			1.36	5,210	49.8	1.008
11	226	18.50	37 73	38.10	5 66	------------	0 87		0 48	------	5,309	49.8	1.010
12	3907	17 18	39 08	38 25	5 49	White -	1.15			1.32	5,897	50 6	0 980
13	3908	15 33	42 05	40 45	2 17	Yellowish brown	1 08	-- --		1 36	5,750	51	0 962
14	3662	11.09	44.02	40 67	4 22	---------- -	2.36	- --	-----	1.40	5,845	51 9	0.924
15	[b]3907	11 35	45.75	41.01	1 89	Brownish gray	2 00			1 31	5,965	52 7	0 897
16	3907	12 18	12 81	37.96	7.02	White.	1 97	---		1 37	5,554	53	0.887
17	3908	18 30	40.44	35 88	5.38	Light brown	0 38	- -		1 31	5,250	53	0 887
18	2348	11 48	40 26	34.76	13.50	------- -	0.83	0.06	0.45	-	5,135	53 6	0.862
19	3662	11 82	43.28	37 06	4 84	-- - -	1 33			1 32	5 485	53 8	0.857
20	3907	17 88	41 32	34.77	6 03	Light brown.	2 10	------		1 32	5,170	54.3	0.842
21	3907	17 56	42 72	35.56	4 16	Brown	2 23	---- -	-- -	1 37	5 815	54.6	0.838
22	3907	9 86	47 58	38 89	3 67	Gray -	2.73			1.20	6,855	55.1	0 817
23	3907	18.96	43 14	32.79	5.11	Brown -	2.15	-- - -	------	1 30	5,105	56.8	0.762
24	3907	17.77	45 18	32 71	4 34	Light brown	2 00	-- --	--	1 33	5,220	58	0.724
25	3908	17 06	50.73	29.12	3.09	Brown	1 21	----	---	1 32	5,180	63.6	0.574
26	2348	10.69	50 47	26.39	2 45	-	0 54	0 12	0 58		4,945	65 7	0.523
27	3907	17.22	51.08	25 77	5 93	Light brown	2 16		------	1.35	4,912	68.5	0.505

[a] Percentage of volatile combustible to total combustible matter.

[b] Fixed carbon / Volatile combustible

[c] Calorimeter calories, 6,487.

TABLE VI.—*Outcrop and upper-bed coals of other localities.*

	Laboratory index	Moisture	Volatile combustible	Fixed carbon	Ash	Color of ash	Total sulphur	Phosphoric anhydride	Iron	Specific gravity	Calorimeter calories	Calculated calories	$\frac{100\ V\ C}{V\ C + F\ C}$	Fuel ratio
						ZAMBOANGA								
	427	4.64	38.38	55.19	1.78					1.27		7 401	41.0	1.437
	2348	6.90	39.91	48.03	5.16		0.62	0.01	0.91			6 450	45.1	1.205
						MINDORO								
3	1387	13.82	40.09	41.62	3.87	Reddish	0.71					6 771	49.1	1.024
						SURIGAO								
4	402	17.37	41.80	33.11	7.88							5 090	55.5	0.800
5	2318	9.35	51.22	20.73	18.60		2.68	0.01	1.45			4 464	71.2	0.401
						RIZAL								
6	858	1.75	38.19	47.86	12.19					1.26		6 935	44.4	1.252
7	2318	6.88	38.69	47.00	5.53		0.71	0.06	0.53			6 400	44.7	1.238
8	2348	5.19	34.69	37.16	22.96		0.86	0.04	0.98			5 022	52.7	1.071
9	1028	8.17	49.32	36.68	5.88		0.48			1.[illegible]		5 710	57.4	0.713
						NUEVA VIZCAYA								
10	3117	13.61	36.56	31.71	18.12	Light brown	1.95					4 688	53.5	0.868
	2570	11.25	53.00	27.64	5.02	Brown	1.72					5 186	65.8	0.520
						TAYABAS								
12	2848	11.04	38.87	27.08	23.02		0.45	0.07	1.50			4 358	58.9	0.[illegible]
						SAMAR								
13	1369	25.2	40.6	31.6	2.6							4 865	56.2	0.778
						PHILIPPINE COAL (SOURCE UNKNOWN)								
14	1128	13.89	32.71	40.23	13.16	Red	0.77				5 [illegible]7	5 968	44.8	1.230
15	8105	2.98	40.96	46.98	9.08	Brown	1.85					6 39[illegible]	46.6	1.118
16	3015	24.80	32.4	36.3	6.50	Reddish						4 887	47.2	1.120
17	1831	4.90	28.5	30.8	36.1	Red						4 205	48.1	1.081
18	3702	12.70	29.30	30.76	27.24	do	0.07			1.37		4 218	48.8	1.050
19	4748	13.08	41.78	42.78	2.36		0.15					5 980	49.4	1.02[illegible]
20	4743	11.91	42.68	38.93	6.48	–	0.28					5 620	52.3	0.911
21	4833	28.1	34.4	30.0	7.5	–	–			1.32	4 992	4 420	53.4	0.872
22	4773	16.10	42.30	34.2	7.4	–						5 170	55.4	0.809

Table VII.—*Analyses of foreign coals.*

AUSTRALIAN.

	Laborat	Moist	Volati stibl	Fixed	Ash.	Color	phu	Phoric anhydrid		S		ulated	100 V.C. / V.C. + F.C.	Fuel ratio.
	225	2 47	32 15	58.20	7 17	--- -- ---	0 22	0 66	0.24	- -	----	7,890	35.6	.810
	1032	2 0	32.6	56 6	8 8	White	1 0		-	---	7,559	7,255	36.6	.737
3	4121	2.7	31.7	54.	11 6	------------	-- --	---	--- -	-- --	6,637	6,895	37.	.704
4	3113	2 81	33.06	52 92	11.22	Gray	0 86					6,865	38.2	.604
5	1209	2 77	36 11	52.66	8.46	-- --do-	0 8					6,910	40.6	160
6	4216	2.49	36.53	58 02	7 96	Yellowish brown						6,975	40.8	450
	1209	2 94	36 57	51 37	9 12	Reddish -	0 88					6,770	41 6	1 421
	8265	2.74	38.63	53 65	4 98	Brown... -	---					7,100	41.9	1.390

JAPANESE.

9	229	1 71	25 53	67 06	5 70	- ----- -	0 11	1 07	0 42	-	-----	7,970	27 6	2 630
10	1207	3 43	36 06	55.51	5 00	Reddish --	1 64				-	7,140	39 1	1 538
11	228	2.38	38.27		6.77	----- -----	0 21	0 32	0.33	- ---	-- --	6,880	42 2	1 375
12	2540	2 48	39.82	53 02	4 68	- -	0 21					7,015	42 8	1 335
		2 89	37.68	50 50	8.98	Reddish -	0 69			-- -	-	6,660	42 8	1 335
		2.61	39 26	51 91	6 19	Brown- -	0 56	0.03	0.45	- ---	------	6,880	43 1	1 323
														1 318
	2540	3 05	37 67	49.84	9 94	-- - -	0 42		---	- --	-	6,580	43 3	1 309
	2781	2 62	39.2	50.68	7 45	Gray - ----	0.28	0.02	0 21	----- -	-- ---	6,710	43 7	1.290
	2846	1 87	40.34	51 85	5.94	------ -	- - --	-	- --- ------	------		6,855	43 7	1 288
	3113	2.49	39 12	50.26	8.13	Gray ----	0 77	- -		----	---	6 660	43 8	1 286
	2346	1 88	40.53	51.73	5 86						-----	6,858	44.0	1.276
	2540	2 91	38.71	48.01	10 87	- -------	0 39					6,875	44 7	1 241
	1207	2.56	39 65	49 03	8 76	Reddish gray.	0 49				-----	6,513	44 7	1 239
	1207	1 26	38.36	47.13	13.25	Gray -------	1.38		-----	-------- ---	- -	6,274	44 8	1 230
	3411	2 10	39 51	48 19	10.20	Light brown	0 17				-	6,436	45.1	1.221
	1033		38 1	45 90	13 90	- ------	2.90			------	6,652	6,165	45.3	1.206
26	2526		42.88	51 11	3.28	-- --- -	0.36			- - --	- --	6,890	45.6	1 192
27	3288		40 66	47 20	9.66	Light brown	1 11			- ---	-- -	6,850	46 3	1 160
28	2346	1.86	40.16	39 45	18 53	------------				----	------	5,565	50.4	0.968
29	2527	2 66	40 34	35.94	21.06	-----------	0 14			--	------	5,245	52.8	0.892

INDIAN.

30	3546	2.04	35.16	52 00	10.80	Light gray -	0.62	- --	-----	---	-----	6,795	40.8	1 480

The upper beds of Philippine coal which have thus far been discovered, and which outcrop at certain places, should for the greater part be classed under the name sub-bituminous, which has recently been adopted by the

United States Geological Survey. The question of the proper classification of coals of this class has often been the subject of discussion,[6] but the new name, in a single word, gives the best idea and is therefore satisfactory.

The moisture, as shown by our many determinations, varies from 5 to 20 per cent in coals otherwise having common properties. From this it is self-evident that any classification attempted on the basis of water content would be entirely false, and in no way applicable to these upper beds.

The fuel ratio and the content of volatile combustible, or of fixed carbon which is a proportional ratio, are not wholly satisfactory as a basis of classification, but for practical purposes are of much assistance, as can be seen by an examination of the above tables. These classifications are the best which can be obtained from proximate analyses. Probably the best simple method for a scientific arrangement is by means of the calorific values as determined in the calorimeter, but as yet we have not sufficient data at hand for this purpose.

Other systems based on the ultimate analysis of coal are important, but neither can any of these be considered thoroughly with reference to Philippine coals for the same reason. Proximate and ultimate analyses and calorific tests of a sample of Batan Island coal were made[7] at St. Louis, Missouri, during the operation of the Fuel Testing Plant of the United States Geological Survey. The analyses are as follows:

Content.		Air dried sample.	Sample as received.
Proximate	Moisture	7.06	22.21
	Volatile combustible	43.94	36.77
	Fixed carbon	43.44	36.86
	Ash	5.56	4.65
Ultimate	Sulphur	1.36	1.14
	Hydrogen	5.55	6.46
	Carbon	62.91	52.66
	Nitrogen	1.33	1.11
	Oxygen	23.29	33.98
	Ash	5.56	4.65
Calories		6,101	5,107
British thermal units		10,983	9,193

A comparison of the above proximate analysis with those of many samples made in this laboratory, and published in *Table I* of this report, demonstrates that the sample now under consideration is almost a perfect average of the published table, and it is believed to be a fair average of the upper beds of Batan Island coal. The carbon-hydrogen ratio, calculated from the ultimate analysis, is $\frac{C}{H} = 11.35$. By adjusting this

[6] Collier A. J.: *U. S. G. S. Bull.* **218**, (1903) 58 et seq.; Smith, W. D.: *Loc. cit.*
[7] By Mr. F. M. Stanton.

and the second phosphorus pentoxide. All of the rubber tubing and rubber connections are of vacuum tubing and all joints are sealed with a solution of rubber in carbon disulphide.

Manipulation of the apparatus.—After the apparatus has been shown to be tight, it is disconnected at A and the sample of coal weighed by difference into the iron tube B from a 40-centimeter bulb tube. By this means the inner surface of the iron tube is kept free from coal to a considerable distance from its open end. The apparatus is again connected as shown in the figure. The gasholder (K) is completely filled with water and the stopcock closed. With the stopcock (H) in the position shown in the figure, the air is exhausted from the apparatus. The air is then exhausted from the tube connecting H and K into the apparatus and the apparatus again exhausted to a pressure indicated by the manometer (F). In the meantime, the eight burners on the right in the illustration have been lighted and that portion of the furnace raised to a red heat. The water is next allowed to flow through the jacket, and the iron tube (B) is put in place in the furnace with the water jacket close to the furnace cover. As soon as the iron tube is red, the number of lighted burners is gradually increased and before long the distillation begins. As soon as the pressure within the apparatus is equal to the atmospheric pressure, the gas is turned into the gas holder (K).

The rate of the production of the gas is regulated by the rapidity with which the number of lighted burners is increased. The best yield is produced with this apparatus when the rate of production is 100 to 200 cubic centimeters per minute. With the use of a higher temperature than that of the experiment, such as is used in a large gas works, this rate could be greatly increased. With this apparatus all of the distillation products must pass through the red-hot iron tube and therefore the quantity of tar is not increased at the expense of the gas, as is apt to be the case in the majority of miniature gas works.

The water discharged from the gasholder is carefully measured as soon as all the gas has been driven off from the coal. When the apparatus has uniformly cooled to a known temperature the volume of gas is corrected to atmospheric pressure.

Condition of conducting tests.— No pyrometer was at hand, therefore it was necessary to construct one in order to read the distillation temperature. The apparatus was made in the following manner:

An ordinary Schaffer & Budenberg pressure-gauge was fitted to a piece of gas pipe of 1 centimeter internal diameter about half a meter long, capped at one end, bent to a right angle in the middle and surrounded by a water jacket close to the pressure-gauge. The gas pipe was filled with mercury and the steel tube of the pressure-gauge with an inert gas (carbon dioxide) to prevent oxidation. When the mercury expands, this gas is compressed, the tube of the pressure gauge straightens out, and the indicator moves over the gauge face. The usual scale of the pressure-gauge was covered with white paper and the pyrometer calibrated by determining its highest point by immersion in a crucible of melting aluminium. For more accurate work, the calibration may be effected by using the following melting and boiling points:

Aluminium	650°
Sulphur	448°
Mercury	360°
Naphthalene	218°
Water	100°

The gas analyses were made according to standard methods. The methane and hydrogen were determined by explosion over mercury and the nitrogen by difference.

The calorific value of the coal was figured according to the formula given on page 878.

The calorific value of the gas was calculated at 30° from the following numbers of J. Thomsen:[20] For the heat of formation of water from hydrogen, Thomsen[21] obtained, as an average of three very closely agreeing numbers, the value $H_2O + O = H_2O + 68{,}388$ calories. The heat of combustion of methane has often been determined and the number obtained under the most painstaking conditions by Thomsen,[22] and a fair average of the reliable values of other investigators is, $CH_4 + 4O = CO_2 + 2H_2O + 211{,}900$ calories. The heat of combustion of ethylene, according to the measurements of Thomsen, is $C_2H_4 + 6O = 2CO_2 + 2H_2O + 333{,}300$ calories. The number obtained by Thomsen for carbon monoxide has not been used, but by preference the round value recommended by Ostwald,[23] which lies between those obtained by J. Thomsen[24] and Berthelot,[25] i. e., $CO + O = CO_2 + 68{,}000$ calories. One gram molecule of a gas = 22.32 liters under standard conditions.

The following factors have been figured from the foregoing data:[26]

	Calories per c. c.
Carbon monoxide (CO)	2.744
Heavy hydrocarbons (C_nH_{2n})[27]	13.455
Methane (CH_4)	8.553
Hydrogen (H_2)	2.756

The gas producing power of five native coals has been determined. For the purpose of comparison a very superior, coking, Australian steaming coal has also been investigated.

RESULTS.

A sample of coal from *Batan Island*[28] gave the following results:

[20] Thomsen, J.: *Thermochemische Untersuchungen*, II.

[21] Idem: *Loc. cit.*, 44; *Pogg. Ann.* (1873), **148**, 368.

[22] Idem. *Loc. cit.*, 94.

[23] Ostwald, W.: *Lehrbuch allg. Chem.* p. 173.

[24] Thomsen, J.: *Loc. cit.*, 284.

[25] Berthelot: *Ann. Chim. Phys.* (1878), (5) **13**, 11.

[26] If it is desired to compare in any way these numbers with those of the Report on the Operations of the Coal testing Plant at the Louisiana Purchase Exposition, St. Louis, Mo., 1904, *U. S. G. S.*, P. P. 48 (1906), **3**, Producer gas, etc., it must be remembered that in each of the last three lines on page 1004 "per c. c." should read, per percentage-content.

[27] All the heavy hydrocarbons are assumed to be present as ethylene. This probably gives too low a result, but the error is on the conservative side.

[28] This was taken from the southeastern end of the island. It is a well known fact that the coals from this region are of a much poorer grade than those from the western end.

Production of gas (in liters).

Weight of coal in grams.	Yield of gas.	Air in gas.	Actual yield of gas.	Actual yield of gas per kilo of coal
47.406	15.217	[a]0.757	14.460	305.020

Analysis of gas.

	Carbon dioxide (CO_2)	Heavy hydrocarbons (C_nH_{2n}).	Oxygen (O_2).	Carbon monoxide (CO).	Methane (CH_4).	Hydrogen (H_2).	Nitrogen (N_2)
Analysis of gas as obtained (per cent)	13.3	5.2	1.75	9.3	24.2	39.2	7.05
Calculated analysis of gas as produced	14.4	5.18	0.7	9.8	25.16	41.3	2.86

	Calories per liter
Calorific value of the gas as obtained	4,062
Calorific value of the gas as produced	4.295

A sample of coal from *Polillo* gave the following results:

Proximate analysis of the coal.

Moisture	Volatile combustible.	Fixed carbon.	Ash.	Total sulphur.	Calculated calories— Of coal.	Calculated calories— Of combustible.	$\frac{100 \text{ V.C.}}{\text{V.C.} + \text{F.C.}}$	Fuel ratio.
5.58	40.99	47.04	6.39	----	5,925	6,785	46.6	1.174

Production of gas (in liters).

Weight of coal in grams.	Yield of gas.	Air in gas.	Actual yield of gas	Actual yield of gas per kilo of coal.
44.690	14.338	0.008	14.330	320.648

[a] During this experiment the apparatus leaked so that the number of cubic centimeters of air has been assumed to be that given and is nearly equal to the quantity of air originally exhausted from the apparatus.

A sample of coal from *Zamboanga* gave the following results

Proximate analysis of the coal

Moisture	Volatile	Fixed carbon	Ash	Total sulphur	Calculated calories— Of coal	Of combustible	$\frac{100\ V}{V+F}$	Fuel ratio
6 98	39 87	48 00	5 15	0 06	6 127	7 304		

Production of gas (in liters)

Weight of coal in grams	Yield of gas	Air in gas	Actual yield of gas	Actual yield of gas per kilo of coal
44 09	13 718	0 008	13 710	302 906

Analysis of gas

	Carbon dioxide (CO_2)	Heavy hydrocarbons (C_nH_m)	Oxygen (O)	Carbon monoxide (CO)	Methane (CH_4)	Hydrogen (H_2)	Nitrogen (N)
Analysis of gas as obtained (per cent)	10 1	6 2	0 1				
Calculated analysis of gas as produced	10 1	6 2	0 65				

	Calories per liter
Calorific value of the gas as obtained	5 135
Calorific value of the gas as produced	

A sample of coal from *Australia*[80] gave the following results

Proximate analysis of the coal

Moisture	Volatile combustible	Fixed carbon	Ash	Total sulphur	Calculated calories	$\frac{100\ V}{V+F}$	Fuel ratio
2 28	36 31	50 25	12 16	0 09	6 550	41 76	1 4

[80] This was taken from the laboratory supply It is a coking coal and was therefore analyzed according to the official method

tion was effected in a Bunsen burner with a constant flow of air, regulated empirically by trial with Polillo gas, and a flow of gas regulated to deliver approximately 7 liters in five minutes. The apparatus used was an ordinary uninsulated copper bath protected from drafts and containing 1 liter of water. The amount of heat lost by radiation was of course very large, but by conducting the experiment in each case for exactly five minutes and raising the water over the same range of temperature, viz, from 30° to about 50°, the results are thought to show the relative calorific value of the gases. The heat value of the water bath, as determined, is 160 calories for each increase of 1° in temperature. It was also calculated[32] from the weight and specific heat of the materials of which it is constructed and a very concordant result obtained.

TABLE VIII.—*Comparative heat value of the gases obtained.*

Name of gas.	Volume of gas burned in liters at 760 mm pressure	Increase in temperature of the apparatus in degrees C	Heat imparted to the water in calories	Heat imparted to the apparatus in calories	Total heat absorbed in calories.	Heat absorbed for each liter of gas burned in calories	Calculated calorific value of the gas	Heat lost by radiation in calories
Batan Island coal	7.21	15.0	15,000	2,400	17,400	2,414	3,115	701
Cebu coal	7.30	17.5	17,500	2,800	20,300	2,780	4,082	1,302
Polillo coal	7.28	24.0	24,000	3,840	27,840	3,824	5,254	1,430
Negros coal	6.88	18.0	18,000	2,880	20,880	3,037	4,490	1,458
Zamboanga coal	6.98	22.5	22,500	3,640	26,100	3,740	5,135	1,395
Australian coal	5.78	21.0	21,000	3,360	24,360	4,210	5,583	1,373
Laboratory oil	6.35	30.5	30,500	4,880	35,380	5,570	7,705	2,135

It would have been better to have regulated the flow of air so that, in each case, the combustion of the gas would have been as nearly complete as possible. The gas generated from Batan Island coal contained a less amount of combustible matter than that derived from the other sources and, with the fixed supply of air, a more perfect combustion was obtained. On the other hand, the gas generated from oil for laboratory use contained a very large percentage of heavy hydrocarbons, and in this case the fixed supply of air was insufficient to effect total combustion. Discrepancies from both of these sources have been included in the last column representing the heat lost by radiation. Nevertheless, the third from the last column of the table represents fairly well the general relation which the calorific values of the gases bear to each other.

Perhaps the relations above determined can better be appreciated if placed together and expressed in a more comparative way, as follows:

[32] Ostwald-Luther: *Physiko-Chemische Messungen* (1902), 191.

Since the Philippine coals used in this study were of the upper or outcropping beds, in which naturally the percentage of ash and especially of moisture, due to climatic conditions, is higher than the average, it is only fair in comparing the results with those of other lands, to do so on the basis of the yield of gas per unit of combustible matter. It will be seen from *Tables X*, *XI* and *XII* that the yield compares favorably with American gas coals and the average, by a small amount, exceeds the average yield from English coals.

The regions represented by this investigation include the largest coal fields of the Islands and show wide distribution. Since the character of the coal in the Philippines and the facts of the gas tests are so nearly the same, conclusions may also be drawn from these results regarding the other regions. Furthermore, it is probable that equally good or even better results could be obtained from a study of the other coals.

An investigation of the by-products of the distillation of these coals has not been made, but it can be stated that the yield of tar is comparatively small.

The producer-gas plant depends not only on the production and utilization of the ordinary coal gas but also on the partial combustion of the fixed carbon which, in an ordinary gas plant, is left behind. Carbon monoxide, the product of the partial combustion, is of comparatively low calorific value, much lower than that of the gas produced from the volatile combustible matter. This explains the results of the work of the United States Geological Survey which show, when viewed from the usual steaming standpoint, that the quality of the producer gas "improves as one descends in the scale of quality of a coal, the best results being obtained from brown lignite." The same tendency is noted in the gas-producing power of native coals, as shown below:

Source of the coal	Heating power of the combustible in calories	Calories per liter of gas	Total heating power of gas produced per kilo of combustible in calories.
Zamboanga	7,805	6,710	1,768,000
Batan Island	7,015	4,298	1,418,000
Cebu	6,965	5,020	1,542,000
Negros	6,985	5,488	1,026,000
Polillo	6,735	5,730	1,910,000
	↓ Decrease in value of the coal.	↓ Increase in calorific value of the gas per unit volume.	↓ Increase in total calorific value of the total gas produced.

This fact is of importance to the Philippines as it suggests a method for the utilization of the low-grade fuels. The disposition of the outcrop coal, which must be mined in opening up the works, and the use of the slack is the question now to be considered and the problem which we must solve. My investigations have been made with outcrop coals of a low fuel ratio, with the particular object of determining their utility. The above results show that the coals tested have satisfactory gas-

producing power and could probably be used in a producer plant with excellent results.

Physically, the Philippine coals are ideal to handle in a producer furnace. They do not swell, they burn steadily, form no clinkers, and the ash would easily be removed automatically. Since the quantity of ash in a producer plant is of no material consequence, it seems probable that dirty coals could be used in this way to great advantage. It is also probable that the outcrop coals used in a producer-gas plant may become as valuable as the best grades of coal used in a steam plant.

With a satisfactory scheme for the utilization of the upper and poorer grade of coal, the mines can successfully be operated and the deeper coal can be used for steaming where a producer gas plant is impracticable. For the production of power, the utilization of our low-grade and outcrop coals for producer gas seems much more promising than any other scheme which has yet been devised for their use.

Amaurornis phœnicura (Forster).

A fine male specimen was taken at Tinabog, January 17; the only previous record of this species for Palawan was made by Platen.

Ægialitis dubia (Scop.).

Tinabog, January 18, one female in badly worn plumage.

Actitis hypoleucus (Linn.).

One specimen from Tinabog, January 15.

Ardea sumatrana Raffe.

An adult male heron taken at Tinabog, January 23, agrees very well with the description of the great slaty heron given by Oates in his Birds of British Burmah, II, page 244. Total length of specimen in the flesh, 53 inches; wing, 19.25; tail, 6.75; tarsus, 6.50; culmen, 7.10.

Butastur indicus (Gm.).

A specimen taken at Puerto Princesa, December 9.

Syrnium whiteheadi Sharpe.

A female example of Whitehead's barred owl in fine plumage was taken at Puerto Princesa, December 16.

Cacatua hæmaturopygia (P. L. S. Müll.).

A female of the Philippine cockatoo from Puerto Princesa.

Prioniturus cyaneiceps Sharpe.

Twelve specimens of the blue-headed racket-tailed parrot were taken at Puerto Princesa in December and January. The females in this series have the feathers of the chin, and to a less extent of the throat and breast, matted with a resinous gum, which injures their appearance as specimens; the males are practically clean and in smooth plumage.

Tanygnathus lucionensis (Linn.).

A female from Puerto Princesa.

Pelargopsis gouldi Sharpe.

Three specimens from Tinabog, Palawan, have been compared with a male from Mindoro and a female from Lubang. So far as I can determine these all belong to the species described as *P. gouldi*.

Alcedo bengalensis Briss.

One male from Tinabog.

Ceyx euerythra Sharpe.

An adult female from Tinabog, January 12; a pair of immature birds from the same locality, January 13.[1]

Gymnolæmus lemprieri Sharpe.

A male from Puerto Princesa.

Caprimulgus macrurus Horsf.

Six specimens of this goat sucker were killed in Palawan during January and February; three are from Puerto Princesa and three from Tinabog.

Caprimulgus jotaka Temm. and Schl.

Bourns and Worcester obtained a specimen of this species in Palawan and one was collected by me in Calayan; the present collection contains the third known Philipppine specimen, a female from Puerto Princesa, December 29. This specimen differs from the one from Calayan in having a greater number of bars on primaries and rectrices; the measurements of the two are equal.

[1] For full description of the various changes in plumage of this species see Bourns and Worcester, *Occ. Pap. Minn. Acad.* (1894), 1, No. 1, 45.

Ciniger palawanensis Tweedd.

A male and a female of this smaller *Criniger* were taken at Tinabog, January 19.

Pycnonotus cinereifrons Tweedd.

A large series of specimens was obtained at Puerto Princesa.

Turdinus ruficrons (Tweedd.).

Four specimens from Tinabog, January 11 and 12, agree with Tweeddale's description and plate.

Anuropsis cinereiceps (Tweedd.).

This curious species is represented by two males from Puerto Princesa, December 14, and one male from Tinabog, January 12.

Mixornis woodi Sharpe.

Specimens from Tinabog and Puerto Princesa. In the description* of this species no mention is made of the numerous obsolete cross bars on the tail feathers.

Cittocincla nigra Sharpe.

A good series of specimens of this species from Puerto Princesa, December 5 to January 31; one specimen from Tinabog, January 12.

Acanthopneuste borealis (Blas.).

A specimen of the willow warbler from Tinabog

Artamus leucorhynchus (Linn.).

One female from Puerto Princesa, December 13.

Otomela lucionensis (Linn.).

Three shrikes in more or less barred plumage were taken at Puerto Princesa in December and January.

Hyloterpe whiteheadi Sharpe.

Puerto Princesa and Tinabog.

Pardaliparus amabilis (Sharpe).

Specimens from Tinabog and Puerto Princesa.

Callisitta frontalis (Swains.).

Fourteen specimens of this nuthatch from Tinabog and Puerto Princesa are all in fine adult plumage. Probably this is *Sitta frontalis palawana* of Hartert.

Dicæum papuense (Gmel.).

Three specimens from Puerto Princesa.

Prionochilus johannæ Sharpe.

Specimens from Puerto Princesa and Tinabog.

Æthopyga shelleyi Sharpe.

This beautiful little sun bird was found both at Puerto Princesa and Tinabog; a number of specimens in fine plumage were taken in December and January.

Cinnyris aurora Tweedd.

One specimen from Puerto Princesa.

Arachnothera dilutior Sharpe.

Eight specimens of Sharpe's spider-hunter from Puerto Princesa, taken in December and January.

Anthreptes malaccensis (Scop.).

A good series from Puerto Princesa and one male from Tinabog.

* Sharpe: *Ibid.*, 7, 577.

Budytes leucostriatus Hom.

Three specimens. It is possible that Philippine birds of this genus belong to the recently described *Budytes flavus alascensis* of Ridgway.[1]

Anthus rufulus (Vieill.).

One specimen of this common pipit from Puerto Princesa.

Anthus cervinus (Pall.).

Three specimens of the red-throated pipit were taken at Tinabog, Palawan, in January.

Anthus gustavi Swinh.

One specimen from Puerto Princesa, taken December 20.

Uroloncha everetti (Tweedd.).

A male and female from Puerto Princesa, December 29.

Oriolus chinensis Linn.

An immature female from Puerto Princesa.

Oriolus xanthonotus Horsf.

Twelve specimens obtained at Puerto Princesa and Tinabog, December 12 to January 23, are in fine plumage.

Chibia palawanensis (Tweedd.).

Three specimens of the Palawan drongo taken at Puerto Princesa in December are in perfect plumage.

Buchanga palawanensis Whitehead.

Two males from Tinabog and four specimens from Puerto Princesa; one of the last taken December 9, 1905, is immature, having acquired but few of the dark, slate blue feathers of the adult. The old feathers are dark smoky brown. Specimens from Culion and Paragua do not differ from each other.

Eulabes palawanensis Sharpe.

Ten specimens from Palawan: an immature female taken at Puerto Princesa, December 22, has the bill lighter and more yellowish than the adults.

Lamprococorax panayensis (Scop.).

Tinabog and Puerto Princesa.

Corvus pusillus Tweedd.

A female from Puerto Princesa.

[1] *Bull. 50*, U. S. Nat. Mus., Bds. N. and M. Am., pt. 3, 8. "Winter specimens from the Philippine Islands apparently belong to this form (*alascensis*), but owing to the fact that no winter specimens undoubtedly belonging to this subspecies are available for comparison their identification is uncertain." Op. cit., p. 10.

II. BIOLOGY OF AMŒBÆ.

In addition to the strictly biological problems, such as the determination of species, life cycle, etc., there are others more nearly bordering upon pathology, the accurate determination of which is vital to an understanding of the disease-producing properties of the parasites. This, for example, is shown in divisions of species into pathogenic and non-pathogenic ones. We do not like to take issue with the zoölogist upon the establishment of species, but when he carries his work as far as the determination of the pathogenicity of individual species, we feel justified in entering the discussion and in so doing it may be necessary, in meeting the issues involved, to use some criticism of a destructive character upon questions which are purely zoölogical, without offering a remedy. To this extent only will we invade the field of the zoölogist, with the exception of considering views which bear directly upon the medical aspect of the subject.

Many discussions of life cycles, classifications, and methods of reproduction of amœbæ, of interest to medical men, have been published from time to time, but these have largely fallen into disuse from lack of confirmation and therefore need not be entered into here.

REVIEW OF RECENT LITERATURE.

In 1903, the late Prof. F. Schaudinn[1] contributed valuable information on this subject, which at once attracted much attention. Many of his observations have repeatedly been confirmed, while other of his statements have been elaborated by subsequent writers. Schaudinn established a new genus, *Entamœba*, to include those amœbæ found in the human intestine, and in this new genus he described two species *E. coli* and *E. histolytica*; the former the so called harmless commensal and the latter a true dysentery producer.

Briefly his observations were as follows:

The genus *Entamœba* includes the amœbæ which inhabit the intestine of man. Two species are described, one pathogenic and the other non pathogenic; they may both at times be found in the same *diseased* intestine, but obviously not together in a normal bowel.

E. coli (the type species) is considered to be harmless and perhaps to be the one reported by Lösch,[2] but first accurately described by Casagrandi and Barbagallo. *E. histolytica* is the pathogenic species and is identical with Jurgen's cat amœba.

The chief characteristics of these two species are as follows:

E. coli, when at rest, shows no sharp distinction between ectoplasm and endoplasm, but this differentiation occurs to a moderate degree in the pseudopodia of the moving parasite.

The nucleus is centrally placed, vesicular (during the vegetative stage), and has a distinct, compact, nuclear membrane. In the center of the nucleus is a nucleolus, which is formed of plastin and chromatin. Other chromatin is also

[1] *Arb. a. d. k. Gesndhtsamte*, Berl. (1903), **19**, 547–576.

[2] Schaudinn states that Lösch's description is so incomplete that he is unable to say whether Lösch had first encountered *E. coli* or *E. histolytica*; however, he is inclined to believe from Lösch's description that *E. coli* was the species described.

distributed in the nuclear cavity as an achromatic network. Multiplication takes place by fission and spore formation. In reproduction by spore formation, the chromatic substance of the nucleus divides into eight parts and, after solution of the nuclear membrane, these become arranged in the protoplasm of the amœbæ as daughter nuclei, and from these nuclei young amœbæ eventually always result.

This reproduction is brought about in a complex manner, somewhat as follows: During the encystment of the amœbæ, fructification occurs. The nucleus divides mitotically, and from the resulting two nuclei two pairs of daughter nuclei are formed in such a manner that each pair has an element from each original nucleus which has been produced by mitotic division. After wandering in the protoplasm for a certain time, these two pairs of daughter nuclei coalesce, so that we again have produced a cell with two nuclei. After a time these nuclei again part by primitive mitosis, giving rise to four nuclei and this process is finally once more repeated, giving an amœba with eight nuclear cysts. About each of these new cysts protoplasm collects, and from them eight young amœbæ develop in the next host.

E. histolytica differs sharply from *E. coli* in having a distinctly formed ectoplasm, which is very refractile and tenaceous. This latter property of the ectoplasm of this amœbæ enables it to penetrate between the epithelial cells lining the mucosa of the colon.

The nucleus of *E. histolytica* is poor in chromatin and it therefore is difficult to recognize; it changes its shape easily and is always excentrically located.

This amœba multiples by fission and a kind of budding or sporogony, the nucleus dividing amitotically. Under unfavorable conditions spores are formed. The nucleus expels some chromatin into the endoplasm, degenerates, and may then be seen to be extruded from the parasite. As the little masses of chromatin approach the periphery, the ectoplasm becomes bulged out and finally the particles of chromatin, with little masses of protoplasm measuring from 3 to 7 μ in diameter, are cut off and become separated from the remainder of the amœba, which now dies. These masses contain a concentric, thread like structure, secrete an opaque membrane and the further processes of development finally become invisible. These bodies constitute the new infecting agent.

The paper of Schaudinn attracted a great deal of attention and some more recent observers have confirmed his results; others have accepted them as established and a few, in addition to confirming his principal observations, have elaborated other characteristics which distinguish between the species. Among the latter, Charles F. Craig's work [4] may be noticed.

Craig's conclusions, broadly speaking, confirm those of Schaudinn, but he proposes *E. dysenteriæ* as the name of the pathogenic species. His descriptions differ from those of Schaudinn somewhat in minor details and he adds a number of other distinguishing points which are intended to render the determination of species more practicable from a simple microscopical examination of the fæces.

Craig's summary of the differences between these species is as follows:

FRESH PREPARATION.—*Size.*—*E. dysenteriæ* usually considerably larger than *E. coli*.

Color.—*E. dysenteriæ* considerably lighter in color and much more refractive than *E. coli*.

[4] *Am. Med.* (1905), 9, 854, 897, 973.

(*b*) ***Ectoplasm.***—Density. Tenacity and dictinction from endoplasm. Color and refraction. Contents, granules, and other elements.

(*c*) ***Endoplasm.***—Presence of, absence of, or variation in size and number of granules. Color and refraction. Presence or absence of red blood corpuscles and other formed, foreign elements. Number, size, and contractility of vacuoles. Spore-appearing bodies.

(*d*) ***Nucleus.***—Location, shape, size, and variations in the amount of chromatin. Presence or absence of nuclear membrane and nucleolus.

In order to obtain the most complete data, it is necessary as far as possible to study the above characteristics in all stages of the life cycle of the parasites.

(d) *Amœbæ as a whole—Size.*—The dimensions of amœbæ vary between wide limits, but probably from 3 to 40 μ in diameter would be the minimum and maximum of size in cultures, and this variation is almost, or quite equalled when the parasites are observed in stools and in the tissues with amœbic lesions. In the naturally encysted stage, the variation is much less, being from about 8 to 30 or perhaps 35 μ. The explanation of the differences in measurements between amœbæ in the encysted and in the vegetative stages is as follows:

All amœbæ are smaller when they are encysted than when in motion. The smallest sizes, often seen in the vegetative stage—that is, the ones below 8 to 10 μ in diameter—are almost surely young parasites, and these do not naturally encyst until they are older and larger. Under certain adverse conditions, such as an extreme lowering of temperature, even the smallest and youngest forms may be driven to assume a cystic appearance, and, of course, under such circumstances they are exceedingly small. However, this change is not a true cyst formation, but *microscopically* it may be impossible to distinguish from real encystment.

Formerly the variation in size of amœbæ was considered to be of importance in determining species, and especially in separating the so-called pathogenic from the non-pathogenic types. However, more recent writers have attributed less importance to it, contenting themselves with the statement that "*E. histolytica*" is in general larger than "*E. coli.*" In our former work we have remarked that measurements of the parasites could certainly not be used in the determination of species. However, after more extended experience, it begins to appear as if measurements, if they could be made with parasites of equal age and in the same environment, might become an important factor in determining species. The trouble, of course, would be the difficulty of being sure of the age and environment of the amœbæ.

With cultures grown from a single amœba, and hence pure, the individual examples vary much in size, particularly in the vegetative stage. In the encysted stage this variation, although present, is much less when amœbæ on the *same plate culture* are considered. Between one culture and another of the same amœba there may be a greater difference,

In general appearance it is usually somewhat more dense than the endoplasm, particularly on its outer border; it may appear as a homogenous structure, or again may present a granular appearance without color, or may be of a grayish or greenish tint. Its association with the internal parts of the amœba may be so close that no line of demarcation can be made out, or again it may stand out with perfect clearness, entirely separated from the endoplasm.

In young amœbæ of whatever species the distinction between ectoplasm and endoplasm is rarely demonstrable, and even in adult types or in encysted forms this may be very difficult. In old, encysted amœbæ the density of the ectoplasm appears to increase and its contraction causes a wavy appearance which, together with the slight, brownish color which may also be present, may with age give a picture comparable with that seen in *ascaris* eggs. (Fig. 29, in Publications of the Bureau of Government Laboratories, Biological Laboratory No. 18.) At times, it may seem perfectly structureless, or thicker and denser on the outer margin, shading off toward the center of the parasite, or in some instances it seems to have a sharp, well-defined inner membrane as well as an exterior one. Often, particularly in this latter type, it contains a few or many granules of assorted sizes, distributed in its substance.

This part of the amœba is probably a much more complex structure, both histologically and functionally, than it is generally accredited to be. Numerous observations tend to show the correctness of this conclusion. At times, during the vegetative stage of the amœba, it allows the passage into and out of the parasite, of bacteria, red blood corpuscles,[a] and of other foreign, formed elements of considerable size, and again, during the encysted stage of the organism, it proves to be almost, or quite, impervious to the most powerful staining reagents.

It is a fact that no satisfactory staining reagent for encysted amœbæ has been found. The ectoplasm may be most intensely stained by almost any common dye, but there is very little penetration to the interior structures. On the contrary, this is not true in the vegetative stage, and an almost equally large number of stains may be used, which will even color the interior structures more intensely than they will the ectoplasm. This, in our opinion, depends more upon variations in the ectoplasm than upon changes in the other structures of the parasite with reference to susceptibility to stains.

Further corroboration of this fact is found by a study of the action of dilute solutions of neutral red upon amœbæ. Solutions of this substance, so dilute that the color in a drop can scarcely be detected by the eye, when

[a] We must not forget here that it is possible that these bodies never actually penetrate the ectosarc, but that folds of this membrane envelop them, so that they are only apparently in the amœbæ, in a manner comparable to the relation between the peritoneum and the abdominal organs.

allowed to come in contact with motile amœbæ are quickly taken up in quantities sufficient to stain various internal portions of the amœba a decided pink color, without at all staining the ectosarc. In resting amœbæ this process is much slower and less complete, and here, in addition, the ectosarc is usually stained. However, in encysted types this stain does not penetrate to the interior of the parasite, but may slightly color the cyst wall. When, at times, one is fortunate enough to see a ruptured cyst in the culture, the neutral red, entering through the opening, colors the contents and often the inner portion of the ruptured ectosarc. This observation tends to show that the variations in staining are due to permeability of the ectosarc rather than to changes in the internal structure of the amœba and further indicates that the outer portion of the ectosarc itself is more dense and resistant than the inner.

A further most interesting phenomenon with neutral red solutions may sometimes be noted in motile amœbæ, in which the first granules to show color may be those in a persistent pseudopod. If this is due to the thinned portion of the ectosarc being more permeable, which appears to be the case, it might also further indicate that, in addition to the function of locomotion which the pseudopodia possess, we must consider them as playing a part in the metabolism of the parasite—such as the absorption of food.

Some, at least, of the numerous phenomena of the ectosarc may be explained by physical laws and their application to the age, environment, etc., of the parasite. However, in addition to this we probably have changes due to vital metabolic phenomena and perhaps others due to variety in species.

(*c*) *Endoplasm.*—The endoplasm is probably composed of a network and of fluids in which are embodied the nucleus, vacuoles, spores, granules, and other vital parts of the parasite, often together with red blood corpuscles, bacteria, and other foreign bodies. The proportionate amount of endoplasm as compared with the whole parasite varies with its environment and the stage of its life cycle in which the observation is made.

Apparently its quantity is smallest and its density greatest in the encysted stage of the amœba. In the small, young parasite it appears homogeneous, and stains easily and intensely, but at later stages it often begins to show granulation, vacuoles, foreign bodies, etc., until in the encysted condition of the amœba it often appears to be contracted and more sharply distinct than at the beginning. It may or may not be distinguishable from the ectoplasm; sometimes the distinction is well marked and the outer margin may appear almost as if surrounded by a limiting membrane. There may be no apparent color in the endoplasm, or, again, various shades of dull-grayish or greenish refraction may be noticed. This variation in color and refraction has already been discussed. Amœbæ from cultures may be made to take on the so-called "diagnostic," greenish refraction with almost as much certainty as they

stool. The reasons governing the inclusion of red blood corpuscles by amœbæ will be discussed in the chapter devoted to the pathogenic character of the parasites.

Bodies which appear like spores may often be seen in the endoplasm of adult amœbæ and in the resting and encysted forms. At times, the arrangement and general appearance of the bodies strongly suggest their being spores, which they probably are, but at other times the picture is not so clear. Whatever the nature of these bodies, they apparently have to do with reproduction, but as we have not been able to follow Schaudinn's observations, nor to establish definitely their course and action, we do not desire to discuss the subject further at this time.

(*d*) *Nucleus.*—A nucleus is probably present in all amœbæ, but in some it is difficult to see it and in others impossible to do so, and further, in the case of amœbæ, it may at one time easily be observed and at another not found. It may be spherical, oval, vesicular or irregular in outline; located centrally or excentrically in the parasite; it varies considerably in size and in the amount of contained chromatin. A nuclear membrane may be very distinct or barely visible and there may or may not be a visible nucleolus.

It will be remembered that one of Schaudinn's strongest points of differentiation between *"E. coli"* and *"E. hystolytica"* (except the distinctions based upon the modes of reproduction) was founded on observations upon the nucleus. In *"E. histolytica"* the location was always eccentric, the shape round, of small size or not visible, the chromatin small in amount and the nuclear membrane indistinct. In *"E. coli"* the picture was almost the complete opposite.

These observations are not altogether true when pure cultures of a single species of amœbæ are considered. The variation in the characters mentioned in such pure cultures is sufficiently great to make at least their diagnostic importance questionable. That Schaudinn's conclusions are not always true in regard to amœbæ in sections from lesions in the bowel and liver may be amply observed by any one sufficiently interested to study such sections.

In *summarizing* this mass of fact and theory concerning the biology of amœbæ, it is readily seen how difficult it is to systematize the points in such a way as to justify classification. We have failed to follow Schaudinn or others in their species determinations, and it appears that many important premises upon which their conclusions were based are not borne out by our work. It seems to us that more work must be done before a satisfactory classification of these protozoa can be made, and until such a time we prefer and believe that we are fully justified in retaining the name *Amœba coli* Lösch, to represent those amœbæ which are found in the intestines of human beings.

The bearing these observations have upon the pathogenicity of amœbæ will be more fully discussed in the appropriate part of this paper.

III. CULTIVATION.

METHODS AND MATERIAL.

Our general plan and technique for the cultivation of amœbæ has not materially been altered since our first communication on this subject.[a] A few changes in the details have been made, most of which have been designed to meet special conditions. These are brought out in the next two chapters, in which pure cultures and symbiosis are discussed.

Up to the present time we have cultivated over two hundred stems of amœbæ from water, soil, vegetables, fruits, and other extraneous sources; from the stools of man and other animals; from the dysenteric ulcers examined post-mortem; and from various experimental amœbic abscesses in animals. We have also, in cases of amœbic cystitis, grown the parasites from human urine and twice from liver abscesses in man. In the latter cases there were both bacteria and amœbæ in the abscesses, and, in one case, cultures made from the discharges after operation were only successful on plates which had previously been inoculated with cultures of the bacteria found in the liver abscess.

No difficulty, as was mentioned in the first paper, has been experienced in cultivating any amœba from water, soil, or other extraneous source. However, the problem with those from the human or other animal intestine is not always so simple, and in a certain number of such cases we have even been entirely unable to grow the parasites. *The most important point to be considered in this connection is that this statement is equally true no matter whether the colon infection is a natural one or whether the amœbæ were originally introduced in the intestine from cultures in which they were multiplying profusely.* To a certain extent at least, this difficulty is brought about by inability to produce satisfactory symbiosis; a further discussion of the causes underlying this phenomenon will be given in the appropriate portion of this paper.

We have found that, whereas when first isolated the parasites thrive best in neutral or slightly alkaline media, this preference can be altered by carefully and gradually increasing the acidity, and by this method the amœbæ eventually can be made to propagate in surroundings in which the percentage of acid is greater than it is ever found to be in the normal stomach; it is also true that encysted amœbæ, after days of exposure to quite strong acid solutions, will again develop when they are placed upon satisfactory media.

This renders it evident that vegetables and other substances contaminated with amœbæ can not be rendered harmless by treatment with weak acids and that the ingestion of acids can not be relied on as a prophylactic measure. This statement is rendered the more positive by the fact that our experimental work has shown that such measures are of even less

[a] *Publications of the Bureau of Government Laboratories*, Manila (1904), No. 18.

avail against the protozoa in the encysted state, and this latter phase of their life cycle is in reality the most dangerous one, even if it is not the only period in their existence when they are a serious menace.

PURE CULTURES.

Pure cultures of amœbæ, which will continue to propagate in media free from other living microörganisms, have not been obtained. That this fact is due to difficulty or inability to free the amœbæ from other associated organisms without injury to the protozoa, has been stated by others, and we formerly tentatively concurred in the belief, but this position must now be abandoned.

Perhaps the easiest and simplest method is to get the protozoa in culture with some delicate bacterium and then place the cultures aside until all the bacteria are dead. Bacteria grow very poorly on media suitable for amœbæ, and some of them, such as *Spr. choleræ*, pneumococci etc., die very quickly under such surroundings unless frequent transplants are made. This process may be hastened by still further reducing the amount of nutritive substance in the amœbæ medium.

Other methods by which we have succeeded in obtaining amœbæ pure and free from bacteria on artificial media are as follows:

Sometimes, in old, encysted cultures, the bacteria which are present may be destroyed by heat and the amœbæ still retain their viability. This is shown by transplants when they are in this condition made to media which contain a satisfactory symbiotic bacterium. The bacteria in an old, encysted culture may sometimes be destroyed, without killing the amœba cysts, by the careful use of certain antiseptic solutions, such as benzoyl acetyl peroxide, succinic peroxide acid, formalin vapor, chloroform, etc.

In some instances success in separating and obtaining living amœbæ, free from bacteria, can be obtained by using the plate methods described in our first paper for securing amœba together with a pure culture of bacteria. For this purpose the original method is only altered in the particular that the bacterial rings, after being made on the plate and the organism allowed to develop, are then killed by exposing the plates to a temperature below the melting point of the agar. The plates are then inoculated in the usual manner within the ring, with the mixed cultures. Occasionally, under these conditions, the amœbæ not only grow through the dead bacteria but also leave the living ones behind them, and in this manner may be found encysted at a sufficient distance from living bacteria, to allow of their being removed with a platinum loop.

Amœbæ free from bacteria may also often be obtained by the injection of the mixed cultures into the livers of monkeys or subcutaneously, and then inoculating subsequent animals with the contents of the abscesses thus produced until finally an abscess is obtained in which the amœbæ are found to be bacteria free.

The most satisfactory method is the one which consists in allowing the bacteria to die out of a culture, leaving the encysted amœbæ behind.

In considering the above-mentioned means of separating living amœbæ from their symbiotic organisms in cultures, it must always be borne in mind that the amœbæ *encyst* under such conditions and do not multiply.

By these methods numerous working cultures of amœbæ, in large numbers and free from bacteria, may be obtained. That the amœbæ are free

within the amœbic protoplasm. This observation is further borne out by the fact that in any culture the most active amœbæ are found along the margins of the culture where the bacteria are also not so numerous.

However, when the cultures are older, and in the more advanced portions of plate cultures which are two or three days old, where both amœbæ and bacteria are more numerous and where many of the amœbæ are older and the bacterial reproduction less active, we often do see amœbæ containing bacterial bodies. Again, amœbæ in culture may be made to take up red blood cells, granules, and foreign matter of various types. This phenomenon is most frequently to be seen in the type of old amœbæ which has just been mentioned and, as with the bacteria, it seems to us that this process of engulfing visible matter is rather due to a lack of selectiveness shown by degenerating amœbæ than to a type of assimilation connected with the nourishment of these protozoa.

Amœbæ, filled with bacteria and other foreign matter, may often be seen rapidly to disintegrate under the microscope, and before encysting they invariably extrude all of these foreign bodies.

INTESTINAL SYMBIOSIS.

(*a*) *Saprophytic.*—There can be no reasonable doubt but that specific and definite symbiosis plays as great a part in the propagation and development of amœbæ in the colon as it does in the test tube, and it is true that the intestinal symbiosis is a changing one due to frequent alteration in the bacterial flora of the bowel, just as it is in the altering bacterial growth in water or vegetable substances. The microörganisms forming the intestinal flora during health are largely saprophytic, and in this respect the flora does not differ largely from that of other sources in which amœbæ are found.

Therefore, it would seem that the propagation of amœbæ which reach the colon alive would depend largely upon whether satisfactory symbiosis could be found there or, in other words, whether there might be present in the bowel, at the time of the entrance of the amœbæ, a sufficient number of bacteria similar to those forming the protozoan's last extraneous or test-tube symbiosis to continue its nourishment until it could adapt itself to the changed environment. Or again, there might be carried along with the amœba upon its entrance into the gastro-intestinal tube enough of its former intimate surroundings to allow rapid multiplication to take place and to establish foci of its last symbiosis in the bowel, before destruction of the parasites could take place.

It would seem that when a satisfactory symbiosis has been established in the bowel by either of the above methods and when amœbæ are propagating in the intestinal tract, their multiplication might continue indefinitely, and under certain conditions which we do not understand this condition might exist without any injury to the intestine. Just to what extent this actually occurs it is extremely difficult to determine.

necessary for the life of the amœba. The latter has become a true parasite and is living at the direct expense of its host. If an amœba is grown with a bacterium such as *B. typhosus*, which is capable of producing a bacteriæmia in monkeys, and if such a culture is injected into a monkey two or three days after the animal has previously been infected with the same strain of *B. typhosus*, then we often obtain multiple, localized abscesses, which are sometimes so extensive as to suggest a general infection. Often such abscesses will contain amœbæ and *B. typhosus*, but at times only the rhizopodia will be found. Amœbæ from such abscesses may usually be recultivated in symbiosis with *B. typhosus*. This, together with the necessity of a previous bacterial inoculation of the animal, shows that notwithstanding the fact that the lesions which are produced are anatomically amœbic, bacteria are still playing a part, though a very indefinite one, in the symbiosis.

If the contents of such abscesses as these are injected directly into a second, healthy monkey, there may or may not be a single abscess at the place of injection but, contrary to the results of the first experiment, no extensive infection is observed; but if, as with the first, this second monkey has previously been given a typhoid bacteriæmia, then the same far-reaching infection may result. However, there is one difference in the second monkey, namely, the presence of bacteria is much less evident, and it may be impossible to reclaim the amœbæ by culture. In a third or fourth monkey, inoculated directly from the abscesses in the second or third, the previous bacterial inoculation may be dispensed with, and rather extensive infections, free from bacteria, may sometimes still be obtained. In other words, a true parasitism on the part of the amœbæ has been established.

Such infections may be transmitted from animal to animal during two or three transfers, rarely through more. The amœbæ can not be cultivated from these sources by using our present means any more than they can be from the bacterially *sterile* liver abscesses in man.

The facts outlined in the above general statement of the building up of the pathogenicity of amœbæ have been repeatedly verified by many and large series of experiments which seem to us to be conclusive. One series is given here and others will be found summarized in Chapter V:

No. 1. Monkey (*M. cynomolgus*) inoculated in the peritoneal cavity with a suspension of an encysted culture of amœbæ and the bacteria cultivated from cabbage.

No. 2.—Monkey (*M. cynomolgus*) inoculated directly into the liver with part of the culture used in No. 1.

After seven days both animals were killed. No. 1 was normal and No. 2 showed an abscess of the liver, from which amœbæ and bacteria were reclaimed by culture.

No. 3.—Monkey (*M. cynomolgus*) inoculated in the abdominal cavity with an encysted culture from the liver abscess of monkey No. 2. After seven days the animal was killed and found normal at autopsy.

At that time we concluded that none of the first three views had been established beyond criticism and that pending a complete solution of the matter, the fourth was the only safe one to consider from the standpoint of public health in the Tropics.

Before entering upon a discussion of our continued work on this subject, a few communications which were not considered in the first paper or which have appeared since, will be reviewed. The most important article which deals in part with the pathogenesis of amebæ is that of the late Prof. F. Schaudinn, which appeared before our first paper, but which was not accessible to us at that time. The other recent papers have largely been confirmatory of Schaudinn's observations.

The conclusions of Schaudinn which bear upon the subject under discussion were based upon the following observations: (1) Amebæ, always corresponding to the description of *E. coli*, were found in 20 to 66+ per cent of the stools of healthy people (people without clinical manifestations of diarrhœa) which he examined. (2) These amebæ, when injected in the recta of kittens, did not produce disease. (3) Amebæ corresponding to his description of *E. histolytica* were only found in the stools of people with clinical dysentery. (4) These amebæ when injected into the recta of kittens produced dysentery. (5) "By studying fresh sections of the intestine infected with *E. histolytica* it is easy to observe the amebæ pushing themselves between the epithelial cells of the mucosa."

Charles F Craig, in San Francisco, found *E. coli* in 65 per cent of the stools of healthy people and in 50 per cent of those of patients suffering from diseases other than dysentery, and he has informed me verbally that he has found them in the stools of 70 per cent of healthy soldiers examined in Manila. His published conclusions confirm and elaborate Schaudinn's. They are:

(1) The intestine of man may be infected with two varieties of amebæ, a pathogenic (*E. dysenteriæ*) and a non pathogenic one (*E. coli*). (2) *E. coli* is found in 65 per cent of healthy intestines and in 50 per cent of those having other diseases, if a saline cathartic is given (3) These organisms can easily be distinguished in both fresh and stained specimens. (4) They differ widely in their manner of reproduction (5) *E. dysenteriæ*, when fed in milk or injected into the recta of kittens, produce typical amebic ulceration. (6) The same procedure (5) with *E coli* gives negative results. (7) Similar experiments with the intestinal bacteria alone do not produce dysentery.

It will be noticed that, with the exception of Schaudinn's statement under sub head No. 5, there is nothing in any of these observations or conclusions which has not already been stated many times by different writers. They were also summarized in our first publication. The statement of Schaudinn in paragraph 5 is a most remarkable one and open to criticism.

We have already dealt extensively with all the points brought out in these new investigations,[a] but as Schaudinn's work has attracted so much attention it seems justifiable again to discuss some of his important conclusions.

Granting for a moment that amebæ may be present in the healthy colon, how can this fact warrant the conclusion that these amebæ are

[a] *Loc. cit.*

harmless or of a non-pathogenic species? Malarial parasites may be found, upon repeated examinations, for months in the blood of individuals living in malarial zones, without chills and fever, or without any other recognizable departure from health; trypanosomata may be present for long periods of time in apparently healthy cattle, carabaos, guinea pigs, or rabbits; filaria may be observed for years in the circulating blood before clinical symptoms develop; but in these cases no one would argue, for example, that the malarial parasite was a harmless commensal.

In discussing the question whether amœbæ multiply in the normal intestine we wish, before detailing our new work, once more to call attention to our original communication in which we concluded that, while amœbæ may occasionally be found in stools from a healthy person, the fact of their proliferation in a normal bowel for a period greater than the longest incubation period of the disease, had not been proved. In view of the statements of Schaudinn, Craig, and others, that amœbæ are so prevalent in the intestines of healthy people, we have again studied several series of cases occurring in all classes of people found in these Islands, and have been unable to find evidence requiring us to change our previous conclusions. Indeed, we could not in a single examination of the fæces, find amœbæ in 70 per cent of real cases of dysentery, to say nothing of examinations of healthy people.

These series, which have been undertaken to determine the prevalence of amœbæ in the intestine, have not dealt with the question of whether or not this situation is a normal one. The series are as follows:

(1) Five hundred and eighty-seven cases from Bilibid Prison Hospital, including all nationalities, were examined. Amœbiasis is quite prevalent in this prison. Of these 154 contained amœbæ, or 26+ per cent. Of 38 consecutive autopsies from the same hospital during the time the above examinations were being made, 16 or 42+ per cent showed amœbic infection of the colon.

(2) In another series of 100 cases, three examinations were made from one week to ten days apart: of these 39 contained amœbæ, or 39 per cent.

(3) Of 318 American patients in the Civil Hospital, mostly admitted because of some gastro-intestinal disturbance, 57 were positive, or 14+ per cent; among 69 native patients in same hospital, 11 were positive or 17+ per cent.

(4) Of 143 stools of American patients examined in the clinical laboratory of St. Paul's Hospital, by Mr. O. Lindquist, resident pathologist to the hospital, 44 per cent were positive; among 217 native patients, 31 per cent were positive. These examinations were largely among patients suffering with diarrhœa or dysentery.

(5) Of thirty examinations in the biological laboratory by other members of the staff from stools sent in, as a general rule, by private patients suffering from dysentery or diarrhœa, 7 were positive, or 23+ per cent.

In addition to differences in the percentage of infections discovered by stool examination, which differences must at least in part be due to the personal equation when the examinations are conducted among

lack of a satisfactory symbiosis or environment for the parasite or to the very complex question of tolerance or immunity on the part of the host, exemplified in so many ways in other parasitic infections of man, rather than to attribute this phenomenon entirely to a lack of pathogenicity on the part of the amœbæ.

In discussing the question of the existence of pathogenic and non-pathogenic amœbæ Schaudinn, as we believe largely owing to false premises, has once more gone over the ground covered by the older workers, which was reviewed in our first publication, and he has again maintained it to be possible to divide amœbæ into two types, pathogenic and non-pathogenic.

In the first part of this paper we have noted the zoölogical considerations upon which he established these two classes, and while we are unable entirely to follow his observations, we dislike to take issue with that part of his work, and this is particularly the case because, as we stated in our previous paper, it is not unlikely that several species of amœbæ will probably be found to exist in the intestine, and it is also probable that more than one species may be found to be concerned in the production of lesions in that organ. However, we disagree with the classification of "*E. histolytica*" and "*E. coli*" as being respectively pathogenic and non-pathogenic for the following reasons:

Amœbæ which may be observed in the stools from patients who have no symptoms of diarrhœa or dysentery (the so-called healthy individuals) are not confined in their characteristics to those given for "*E. coli.*" Protozoa answering more nearly to Schaudinn's "*E. histolytica*" are surely to be isolated from the above class of cases, and probably with almost as great frequency as "*E. coli.*" An amœba which we have in culture (11524 of our first paper) at one time was very virulent, producing dysentery when it was ingested by monkeys or man. After about three years of cultivation on artificial media, no lesions could for a time be produced with this organism, although the exact technique of our first inoculations was repeated. This amœba has again become virulent by the manipulations which we have used to produce animal infection with all classes of these protozoa.

It is also true that amœbæ answering partially to the description of "*E. coli*" may, and often are, the only ones to be found in the fæces, in ulcers, or in sections from some of the most severe cases of the infection in man. Cultures of amœbæ of this class can be so manipulated as to produce amœbic ulceration of the colon in monkeys and in man, and furthermore they can be made to produce multiple amœbic abscesses in the lungs, liver and omentum after intraperitoneal inoculation.

One of our amœbæ is a very satisfactory type of "*E. coli.*" It has a prominent central nucleus, it is a slowly moving organism, its ectoplasm and endoplasm are difficult to differentiate, and in many other characteristics it conforms to the type. With this organism, which is one

of our most recent cultures isolated from vegetables purchased in a Manila market, we have produced liver abscesses in monkeys after intraperitoneal inoculation.

ORIGINAL WORK.

In our first publication conclusive evidence was given of the pathogenic character of amœbæ in producing ulcerative colitis in man and monkeys. We now wish to offer more evidence upon this point and in addition to show that the amœba is capable of a very definite parasitism. Furthermore, we wish to demonstrate that morphologically the organisms which produce this colitis may resemble either "*E. coli*" or "*E. histolytica*" as they are described by Schaudinn and that they may be isolated from a variety of sources. It is almost impossible to conceive of man ever before having been in any way associated with some of these sources.

We have used cultures of encysted amœbæ in all of our experiments, because we have long been convinced that these are the most certain to be infectious.

INTESTINAL INFECTION.

SUMMARY OF EXPERIMENTS.[11]

(1) If amœbæ from *any* source are cultivated on artificial media, and the encysted cultures are then fed to monkeys by means of a stomach tube, after a variable time the stools of some of the animals will contain the organisms. The usual symptoms of infection are observed, and at autopsy the lesions and parasites characteristic of amebiasis will be found. However, in the cases of many of these animals no bad results follow the introduction of the organisms and amœbæ are never found in the stools. In others, after the infection is established, the animal may finally entirely recover and the amœbæ disappear.

In still another class, amœbæ after a certain incubation period, may be found for a time, finally to disappear from the stools without any visible symptoms of infection. However, if the animals are killed, in some of them amœbic lesions will be found in the colon. One monkey which was infected in the manner detailed above developed an amœbic abscess of the liver which was found at autopsy, and in another an abscess of the lung was observed.

The percentage of infections to be included in this class of experiments does not appear to be materially inflenced by the type of the symbiotic bacterium which was present in the cultures, nor are the results very different when the amœbæ are in symbiosis with more than one variety of bacteria. If large doses of the symbiotic bacteria alone are first fed to the animals for several days and if then the culture of the amœbæ and the bacteria is ingested, the percentage of infections is increased.

[11] See also *Publications of the Bureau of Government Laboratories*, Manila (1905), No. 18, 70 76.

(2) The percentage of infections is greater than it is in animals fed in the manner given under 1, if *suspensions* of cultures of amœbæ are inoculated directly into the cæca of monkeys by hypodermic injections, either after opening the abdominal cavity or by direct puncture through the abdominal wall.

However, even by this method amœbic ulceration does not always follow, the results being influenced by the same agencies which cause a variation in the feeding experiments.

(3) Amœbic infection can be produced in monkeys by rectal injections of cultures of the organisms, but the results of this procedure are less certain than they are when either of the other two methods is employed. The study of the influences which govern these results has not brought satisfactory conclusions.

We have practically abandoned experiments which depend upon introducing the organisms into the gastro-intestinal canal, because a more accurate method, which we will presently describe, has been developed by us. In the intestine the conditions for the study of amœbic or other infections are very complex and show little beyond the proof that amœbic ulcers may be produced by the introduction of cultures of the protozoa; therefore, experimentation on other organs of the body serves more easily to solve the question of the pathogenicity or non-pathogenicity of the organisms.

Our work in specific regard to the intestine seems to have established the following:

(*a*) Amœbæ are the causative agents in certain infections of the bowel.

(*b*) Bacteria play an important part in this process by furnishing symbioses for the amœbæ during the establishment of a more genuine parasitism.

(*c*) In many of these infections true parasitism probably is not reached in the bowel, for here, even in the amœbic ulcers, the bacteria still help in the formation of a symbiosis. In this respect bacteria may be considered to influence the fundamental etiological agent. Certain of the pathogenic bacteria which are in symbiosis with the amœbæ must certainly also take a more active part in the etiology of the lesions. Combinations with this class of organisms usually influence the symptomatology of the disease and they may always be recognized in the histological study of tissues taken from such cases.

(*d*) It is also true that pathogenic bacteria which are not concerned in the amœbic symbiosis may enter the intestine and play a part in the subsequent course of the amœbic lesions, and therefore it is probable, although it is not proved, that the simplest and purest amœbic lesion of the bowel is one where pathogenic organisms are not present and in which the bacterial symbiosis takes place with a non-pathogenic bacterium.

cultures will sometimes produce infection when they are injected into the abdominal cavity.

(*b*) If the subcultures are injected into the abdominal cavity of a monkey or guinea pig which six to sixty hours before that time has been inoculated with *B. typhosus*, then abscesses are much more likely to be formed in the omentum and elsewhere. In one series of experiments they were produced in four out of five monkeys. These infections are sometimes very extensive, many abscesses may occur in the omentum and also in the liver, spleen, abdominal wall and lungs. It is impossible long to continue these infections from animal to animal by employing subcultures, because after the first, or at most the second animal has been used, the amœbæ present in the abscess will no longer grow on artificial media, even in symbiosis with the original *B. typhosus*. However, the infection may be continued through five successive animals by direct inoculation of the abscess contents of one animal into the peritoneal cavity of the next one, the latter having previously been infected with *B. typhosus*. After the second or third animal has been injected, then the preliminary treatment of the monkey by inoculation with *B. typhosus* may be omitted, but the infection can then be continued through no more than two additional animals. We can not explain the failure to continue this high parasitic type of infection by intraperitoneal injections any more than we can similar infections in the liver, but it is probably due to similar causes, which may be the inability of an organism which normally is saprophytic to continue an existence of absolute parasitism.

INTRAVENOUS INFECTION

Infection occurred in one out of three monkeys which were inoculated intravenously with encysted mixed cultures of amœbæ and *B. typhosus*, obtained from an experimental liver abscess. These monkeys had previously been inoculated with *B. typhosus* alone. In the one positive result, the lesion consisted of two small amœbic abscesses in the lung and one, about 5 millimeters in diameter, in the spleen. We have already encountered two cases of general infection in man. However, in one of these the distribution was the same as that of an associated parasite, *P. westermanii*, and seemed to be due to a lymphatic rather than to a blood distribution.

IMMUNITY.

The influence upon the production of lesions by bacterial immunity possessed by animals against the symbiotic bacteria in amœbic cultures has not, as yet, received the attention the subject deserves.

It may be recalled that it was brought out in our first publication that, whereas abscesses were produced in the livers of a certain percentage of monkeys by the direct inoculation of cultures of amœbæ and *Spr. choleræ*, that such an abscess did not occur in one monkey which had previously been immunized against that organism. It was furthermore noticed

To judge from the facts which have been brought out in this work, we conclude that the manner of invasion is similar to that belonging to other infections. The primary action seems to be due to a toxic secretion which is a product of the amœbic symbiosis, acting upon the exposed cells of the mucous membrane. It is likely that, in addition to considering the chemistry of symbiotic products, we can not ignore the receptive condition of the cells themselves, influenced, as they may have been, by their evironment. It is probable that the mechanism of the intestinal infection does not materially differ from that taking place in the liver and other organs, excepting that it is more complex because of the mixed and changing environment to which the amœbæ are exposed.

In discussing the production of liver abscess it has already been pointed out by Musgrave[18] that something more than the mere presence of pathogenic amœbæ in the liver is necessary before abscess formation takes place. It was shown that the presence of amœbæ in the liver, after the colon has already become ulcerated, must be of very frequent occurrence.

When the data brought out in this paper are considered in this connection, two facts stand out prominently: (*a*) Only a comparatively small portion of actual amœbic infection of the liver results in abscesses or the production of any other changes which we can at this time call specific; (*b*) abscess formation and the bio-chemistry of amœbic lesions in general is a complex phenomenon not yet fully elucidated. Probably it depends, at least partially, upon related alterations which occur both in the parasites and in the involved tissues.

VI. SUMMARY.

In comparing our observations with some of the recent literature upon the biology of amœbæ it appears that the establishment of two species of amœbæ for the human intestine is hardly sustained by the data given

While the multiplicity of species of amœbæ inhabiting the human intestine is not questioned, it is found by working with cultures of pure species, grown from a single ameba, that variations in some of the characteristics are as great as are many of those given by some authors for species determination.

We have not actually observed the entire life cycle of any amœba, but known forms of reproduction are: (1) Simple fission and less frequently budding during the vegetative stage, and (2) one or more forms of reproduction from an encysted stage either by some type of sporulation, sporogony, or schizogony or by a phenomenon which has been observed in cultures, namely, the escape of a single ameba from a ruptured cyst.

The size of individuals of pure species of amœbæ in culture varies with the age and environment of the parasite. In the same plate culture all ages and sizes are found in the vegetative stage. In naturally encysted

[18] *Phil. Journ. Science* (1906), 1, 552, 553.

ILLUSTRATIONS.

In figs. Nos. 1 to 9, inclusive, the magnification in all is exactly 800 diameters. The reader is requested while examining these reproductions to bear in mind the characteristics which have been designated as distinguishing between "*E. coli*" and "*E. histolytica.*"

Figs. Nos. 1 to 3, inclusive, photographs of amœba "γ." This amœba was grown from vegetables and is a pathogenic parasite. With cultures of it we have produced amœbic colitis and amœbic abscesses in the liver, lungs, omentum and spleen of animals.

No. 1. Forty-eight-hour transplant, inoculated from an old, encysted culture.

No. 2. Twenty four hour transplant from No. 1.

No. 3. Twenty-four-hour transplant from No. 2.

The amplification in these three pictures is exactly the same (800) and shows the variation in size in a pure species of amœba. This is quite decided between the encysted forms in No. 1 and the vegetative form in No. 3. In No. 1 are shown fully developed cysts, others in which reproductive changes are appearing, and several small vegetative forms which have escaped from cysts. Encysted amœbæ may also be seen, showing the rather dense, prominent ectosarc sharply distinguishable from the endoplasm as in Schaudinn's "*E. histolytica*" but, on the other hand, in the same amœbæ the prominent central nucleus with a distinct nuclear membrane, as in "*E. coli*," may also be seen. Early reproductive changes are shown in several of the amœbæ, and in these the line of demarcation between ecto- and endo-plasm is less marked. No. 2 shows a cyst containing a single young amœba and another ruptured cyst from which an amœba is about to escape. This phenomenon was also shown in figs. 29 to 32 in our first report. No. 3 represents a vegetative form, probably a young but full grown parasite; except in the large pseudopod which is thrown out, the distinction between ecto and endo-plasm is not sharp, and the nucleus accredited to "*E. coli*" is also present.

Figs. Nos. 4 to 6, inclusive, photographs of amœba "cabbage." This amœba was grown from cabbage and is a very pathogenic parasite. With cultures of it any of the lesions described in this paper may be produced.

No. 4. Forty-eight-hour-old transplant, showing young vegetative forms and an early cyst.

No. 5. Twenty-four-hour transplant from an old, encysted culture, showing four old cysts and two bunches of young amœbæ freshly liberated.

No. 6. Vegetative form of figs. 4 and 5. The ectoplasm is prominent in the encysted forms in figs. 4 and 5, and in the fresh cyst in fig. 4 the differentation from endoplasm is distinct. None of these amœbæ show a nucleus. In the vegetative form of the same amœba in fig. 6 we have the prominent nucleus described for "*E. coli*" as well as the lack of differentiation between ecto- and endo-plasm.

Figs. Nos. 7 to 9, inclusive, photographs of amœba "11524." A description of this amœba will be found in our first report. It was grown from the stool of a dysenteric patient.

No. 7. Old, encysted culture, showing distinction between endo- and ecto-plasm and absence of nucleus.

No. 8. Transplant from No. 7, showing two cystic and three vegetative forms.

No. 9. Transplant from No. 8, showing full grown vegetative form. The spinous pseudopodia formation, which was distinct in the specimen viewed under the microscope, is barely visible in the photograph. The nucleus which was very distinct is slightly out of focus.

In this connection attention is invited to figs. 7 to 11, inclusive, of our first report, which are also reproductions of this same amœba.

Fig. No. 10. Twenty-four-hour-old transplant from growing culture of an amœba from a dysenteric stool. Amplification about 1,200. Showing very prominent nucleus with heavy nuclear membrane and nucleolus situated eccentrically. The distinction between ecto- and endo-plasm is usually very sharp in this amœba, and its motility is as a rule very sluggish.

THE TYPES OF BACILLI OF THE DYSENTERY GROUP.[1]

By Y. K. Ohno.

(From the Institute for Infectious Diseases, Tokyo, Japan.)

INTRODUCTION.

The etiological importance of *Bacillus dysenteriæ* (Shiga) as the causative factor in dysentery was first proved in Manila by Flexner (1), Strong (2, 3), and Musgrave (3), and Strong strictly distinguished between two types of dysentery, viz, the bacillary and the amœbic. The latter type, as a rule, pursues a chronic course and amœbæ can generally be discovered at all times in the stools, whereas the former is an acute disease, the causative factor of which is *Bacillus dysenteriæ*. Bacilli of apparently identical characteristics were later isolated from dysenteric stools in Europe, Asia, and America, so that to-day the etiologic importance of *Bacillus dysenteriæ* in sporadic, endemic, and epidemic dysentery has become fully recognized.

Subsequently, in the year 1900, when the papers of Flexner, Strong, and Musgrave had already been published, Kruse (4) reported on an epidemic of dysentery occurring in Laar, Germany.

At that time Kruse thought he had encountered an organism which differed from the Shiga bacillus. This led to a further discussion of the subject of differentiation by Shiga and by Flexner, who claimed motility for *Bacillus dysenteriæ*, and by Kruse who had never observed this phenomenon in any of his cultures. In June, 1901, Kruse (5) contributed a second paper in which he concluded that Flexner's bacillus was probably closely related to, but still a variety of the species he (Kruse) had isolated, and, although he had not examined Shiga's cultures, he believed from the similarity in the description between Shiga's and Flexner's organisms and from the geographical situation of Japan and the Philippines that the two cultures were identical, and consequently that his own and Shiga's bacillus were very similar organisms. In this same paper he also reported on epidemic dysentery in insane asylums and from some cases of this nature he isolated organisms which could not be distinguished morphologically or culturally from the genuine dysentery bacillus, but which differed from it in their serum reactions. By a careful comparison of their action with the

[1] Read before the Section of Bacteriology, Hygiene, and Infectious Diseases of the Japanese Medical Congress, March 4, 1906.

serum of dysenteric patients and with immune serum from animals, he not only showed that these organisms differed from the dysentery bacillus he first isolated but that they apparently constituted a second variety or species.

Therefore, Kruse was the first who drew attention to the variations in the agglutinability of the dysentery bacillus. On the basis of this distinction, and in spite of the similarity in morphology and in all cultural properties, known at that time, between *Bacillus dysenteriæ* and the organism isolated from cases of institutional dysentery, he proposed to designate the latter as *pseudo dysentery* bacillus.

The investigations of Spronck (6) seemed to confirm this distinction, he having isolated a similar organism from patients suffering with dysenteric symptoms in Utrecht (Holland), in which, however, the clinical manifestations were not so typical as those encountered in acute, epidemic dysentery. However, Flexner (7) and later Vedder and Duval (8) opposed this view and emphasized the fact that the variation in agglutinability was only one of degree and that there was agreement in other properties.

In September, 1902, Duval and Basset (9) reported on the etiology of the summer diarrhœas of infants. From such cases they isolated an organism which they believed to be identical with *B. dysenteriæ* not only in morphology, cultural features and pathogenesis, but also in its reaction with specific serum. Park and Dunham (10) next isolated an organism which produced indol in peptone solution and which, while it agreed in its agglutinative reactions with the Flexner strain found in Manila, differed in this respect from the one Shiga obtained in Japan. Hiss (11) and Klopstock (12) endeavored to differentiate dysentery bacilli from typhoid and colon bacilli by taking advantage of the distinct reaction in fermentation.

The studies of Lentz (14) and of Hiss and Russell (15) further emphasized the cultural distinctions between the different dysentery bacilli and the variations in their agglutinative reactions. These investigators found that two types of bacilli could be distinguished, one which fermented mannite and the other which did not cause acid production in this medium. The agglutinative reactions of these two types indicated further that the so-called "pseudo-dysentery" bacillus regularly fermented mannite, while the other, the original type of *B. dysenteriæ*, was unable to act upon that substance.

Martini and Lentz (13) a short time after, made additional studies upon the agglutination of these two varieties of dysentery bacilli, in which they employed the serum of a goat immunized to the "Shiga" strain of the bacillus. Their results are interesting in showing that such a serum agglutinates only the "Shiga"-"Kruse" epidemic variety in high dilutions, but that some other strains of dysentery bacilli (all of which do not attack mannite) agglutinated in lower ones of 1:25 to 1:50. On the basis of this difference in agglutination and in behavior toward mannite, they uphold the distinctions proposed by Kruse between the so-called "dysentery" and "pseudo dysentery" bacilli.

Park and Carey (16) called attention to the fact that all varieties of dysentery bacilli (obtained from dysentery cases), which produce indol in large amount and which develop acid from mannite, distinctly differ in their agglutinative reactions from those which do not act upon mannite and which produce no indol, or only a trace of that substance.

Gay (17), in a study of the types of dysentery bacilli in relation to bacteriolysis and serum therapy, repeated the experiments of Lentz and of Hiss and Russell

and confirmed their results as to the action of the bacilli on mannite. As regards the bacteriolytic action of serum upon the two types, he showed that the bacteriolysis in vitro takes place when correspondence exists between the type of bacilli and of immune serum, irrespective of their strain, and it fails to occur when the types are not in conformity. This view was also supported by Martha Wollstein (18), who, in the examination of the stools of one hundred and fourteen infants suffering from infantile diarrhœa found dysentery bacilli in thirty-nine cases. Thirty-eight of these fermented mannite and maltose and produced indol, while one, obtained from the most severe case, did not ferment mannite, thus agreeing with the "Shiga" type.

Park, Collins, and Goodwin (19) in May, 1904, published a paper dealing with the group of dysentery bacilli and the varieties or organisms which should be included in it. The results of their agglutination and absorption tests indicate that the bacilli isolated by themselves and others may be separated into at least three types or varieties. These display differences in their fermentative characters, and the grouping thus arrived at substantiates the classification based on the fermentation test which was made by Hiss. The first type is represented by the original "Shiga" strain. None of the bacilli belonging to this class produce indol (with the exception of a trace) and they do not ferment mannite, maltose, or saccharose. The organisms composing the second type ferment mannite with the production of acid, but do not split maltose or saccharose in peptone solution or produce indol. The bacilli of the third type approach nearest to those of the colon group, since they not only produce indol and actively ferment mannite but also act energetically upon pure maltose and feebly upon saccharose. Animals injected with each of these types develop specific immune bodies and agglutinins, all the bacilli agreeing in cultural characteristics. In consideration of all the facts, they add that it seems incorrect to designate the mannite fermenting groups as pseudo-dysentery bacilli.

Hiss (20) by comparing the fermentative action of the different strains on the five carbohydrates (dextrose, maltose, saccharose, dextrin, and lactose) and alcohol mannite, succeeded in giving what seemed a reliable classification and this division also accorded with the observed agglutinative phenomena. His conclusions are as follows:

(1) The bacilli of dysentery fall into four major groups which have fermentative and agglutinative characters distinguishing them from one another. However, sub-groups, due to differences in agglutinative characters alone, may occur among cultures having the same fermentative functions, so far as has been determined

(2) The four major groups are as follows: The *first*, represented by the Shiga-Kruse bacillus, ferments dextrose readily and at times maltose, after many days; the *second* one, represented by Hiss's "Y" bacillus, ferments dextrose and alcohol mannite (maltose and saccharose may be fermented but not with ease); the *third*, represented by Strong's Philippine culture, ferments dextrose and mannite with ease, saccharose is fermented with comparative readiness (and maltose at times slowly); the *fourth*, represented by Flexner's Manila culture, ferments dextrose, mannite, maltose, saccharose, and dextrin with ease.

(3) Agglutination and absorption tests show that the agglutinative characters of these different groups are specific.

The American observers are generally inclined to consider the so-called acid and non-acid types of dysentery bacilli to be of equal etiological importance and some of them regard the differences between the two

One strain from Kyoto of the acid type which was isolated by Dr. Yoshida (30), who regarded it as a variety of the dysentery bacillus (Shiga). The organism was identified by me.

A comparison of all these cultures revealed the fact that they could not be distinguished one from another, either culturally or morphologically, although *minor* differences were shown to exist, particular in their characteristics in artificial culture media.

In addition to the agglutination test, the action of bacteriolytic immune serum upon all the strains was studied, since this is perhaps the most important test for the differentiation and identification of bacteria. This was performed *in vitro*, as the virulence of the different strains varied greatly.

TYPES AS DETERMINED BY FERMENTATION.

All the strains of dysentery bacilli mentioned above have been cultivated for many generations on artificial media (common agar). In many instances in which the organisms were isolated by myself, the first fermentation tests were made immediately upon isolation; in others this was impossible, as the organisms were sent to me subsequent to their isolation. Multiple tests as proposed by Hiss have been made, and the final tests of all the strains were performed more than a year after their isolation, because my investigations on this subject continued for about one year. Whenever unexpected reactions or appearances were manifested, fresh plate cultures were made to determine the purity of the original culture and the experiments were repeated with the various colonies. The same results were invariably obtained. Dextrose, maltose, saccharose, dextrin, lactose, and alcohol-mannite were the fermentable substances used. The tests with galactose, lævulose, and inulin were omitted since, according to Hiss, no differences of value as distinguished from those obtained with dextrose, were shown to exist on cultivation in this medium, and none of the bacilli fermented inulin with acid production.

The common peptone water solution was used as a nutrient medium, to which the carbohydrates were added in sufficient quantity to form a 1.3 per cent solution, as suggested by Lentz. Merck's preparation of litmus, highly purified, was used in all the experiments and was added in sufficient amount to form a 0.6 per cent solution. The peptone medium was composed of 0.5 per cent sodium chloride and 1 per cent peptone [sic.] in 100 cubic centimeters hydrant water; it was sterilized in the usual manner and its reaction tested and, if necessary, it was neutralized. Sugar was then added and the medium placed in tubes and sterilized for from ten to fifteen minutes on three consecutive days. The color of the medium is of a light blue. A sufficient acid production changes the medium to a red color; when acid is formed to a less extent, the color is altered to purple. The variations in composition of the nutrient media to which the sugars were added, and the variations in the salts present, which Hiss undertook were not performed by me

The *fourteenth*, or "N" type, is represented by the culture "Korea III," which attacks dextrose, saccharose, dextrin-lactose, and alcohol-mannite, while it does not ferment maltose.

The *fifteenth*, or "O" group, is that represented by "Kyoto" as the type. As we have seen, this organism has the ability, besides mannite, also to ferment dextrose, maltose, saccharose, dextrin, and even lactose. The organism is the same as that of "Duval," group of Duval (34).

These fifteen types of dysentery bacilli may again be divided into two major groups according to their different behavior in regard to the fermentation of alcohol-mannite, the members of one not fermenting and those of the other attacking mannite with the production of acid. The first major group (so-called non-acid bacilli) comprises organisms corresponding to the ones described by Shiga-Kruse as the cause of epidemic dysentery. Types "A," "B," "C," "D," "E," and "F," which I have studied, belong in this group. Among them only the "A" and "B" types were carefully identified by previous authors, whereas the other four have been recognized by myself. The second major group (so-called acid bacilli), separated from the first by their power to ferment alcohol-mannite, is composed of organisms which may again be separated into nine groups by their different action in fermenting other carbohydrates. Among the nine groups which ferment mannite only, four have been found in Europe and America. These are "G" type ("Y" type of Hiss), "H" type (Strong's type of Hiss), "L" type (Harris type of Hiss), and "O" type ("Duval" type of Duval), while the other five have been identified by me in different strains obtained in Japan, Korea, Manchuria, and from the Baltic fleet.

However, this method of division, into non-acid and acid types of the bacilli according to their power of fermenting alcohol-mannite, can not be considered to be a correct one. As we have seen, even among the two major types all the strains differ from each other in their power to ferment the different carbohydrates, but these characteristics are not sufficiently regular to enable us always to divide them distinctly. On the other hand, moreover, when we come to study the agglutination and bacteriolytic reactions of the different strains, we find that a division into similar groups is not justifiable. Arguing from my observations, I can see no reason for the separation of the acid and non-acid bacilli into two distinct groups as proposed by Lentz, and no justification for designating any bacillus among the group of organisms which causes dysentery as a "pseudo-dysentery" bacillus as proposed by Kruse. It seems to me that we are rather compelled to consider all fifteen types of the dysentery bacilli as comprising a single group and constituting the whole of this group of organisms and to admit that minor distinctions which sometimes irregularly occur may exist between the different strains.

TABLE VII.—*Agglutination of the fifteen types of dysentery bacilli with dysenteric immune serum prepared from several strains*—Continued.

Type.	Organism.	Mannite fermentation.	Rabbits' immune serum.			Goats' immune serum.		Horse immune serum "Shiga."
			"Port Arthur."	"Korea III."	"Tokyo IV."	"Shiga."	"Rio-yang I."	
G	Tokyo I		1-80	1-500	1-7,500	1-750	1-750	1-800
H	Korea II		1-600	1-2,000	1-1,000	1-1,000	1-2,000	1-2,000
I	Rio-yang I		1-80	1-800	1-750	1-3,000	1-5,000	1-1,000
J	Baltic II		1-200	1-800	1-5,000	1-100	1-800	1-500
K	Tokyo III	Acid	-100	1-2,000	1-750	1-200	1-1,000	1-2,000
L	Yamaguchi		-200	1-2,000	1-750	1-750	1-5,000	1-2,000
M	Tokyo IV		1-20	1-300	1-5,000	1-500	1-750	1-500
N	Korea III		-200	1-2,000	1-500	1-2,000	1-5,000	1-2,000
O	Kyoto		-100	1-1,000	1-2,000	1-7,500	1-100	1-2,000

In Table VII we see the high agglutination of "Korea II" (an acid strain) produced by dysenteric immune serum prepared with "Port Arthur" culture (a non-acid strain). *Vice versa* a similar result in agglutination was obtained with dysenteric immune serum prepared with "Korea III" (an acid strain) on "Rio-yang II" (a non-acid strain). It may also be seen that immune serum "Tokyo IV" (an acid strain) has the power to agglutinate "Rio-yang II" and "Wakayama I" (non-acid strains) in very high dilutions even with dysenteric-immune rabbit serum, which is designated as a "differentiating serum" by German authors. With the immune serum of goats and of horses, as Shiga and some German authors have reported, there is very little difference in the agglutinative reactions between both the acid and the non-acid types. In addition, a study of Table VII will reveal the results of the agglutination tests of all fifteen of the strains of dysentery bacilli with immune serum of rabbits, goats, and horses; by a glance it may at once be seen, that there is no apparent distinction in agglutinative reactions between the so-called mannite fermenting and non-fermenting organisms and that no such distinction can correctly be made.

STUDIES ON BACTERIOLYSIS.

Bacteriolysis by immune serum being an important method in the identification and differentiation of bacterial species, it seems strange to me that most authors who have studied the differentiation of the types

TABLE VIII.—*Bacteriolysis of "Gaiping I" ("A" type) with serum from horse, "Shiga" ("A" type).*

2 milligram fresh agar culture "Shiga" bacillus in 1 cubic centimeter salt solution.	"Shiga" dysenteric immune serum, complement free.	Fresh normal guinea pig serum.	Plate colonies after five hours.
c	None.	None.	Innumerable.
c	0.1 c. c.	None.	Thousands.
c. c	None.	0.2 c. c.	Innumerable.
c. c	0.1 c. c.	0.2 c. c.	Do.
c. c	0.05 c. c.	0.2 c. c.	Do.
c. c	0.025 c. c.	0.2 c. c.	Thousands.
c. c	0.01 c. c.	0.2 c. c.	One thousand.
c. c	0.005 c. c.	0.2 c. c.	Hundreds.
c. c	0.0025 c. c.	0.2 c. c.	Do.
c. c	0.001 c. c.	0.2 c. c.	One hundred.
1 c. c	0.0005 c. c.	0.2 c. c.	Almost none.
1 c. c	0.00025 c. c	0.2 c. c.	Few.
1 c. c	0.0001 c. c	0.2 c. c.	Hundreds.
Control, no bacilli	None.	0.2 c. c.	None.
Control, no bacilli	0.1 c. c.	None.	Do.

TABLE IX.—*Bacteriolysis of "Rio-yang I" ("J" type) with serum from rabbit, "Tokyo I" ("G" type).*

0.002 milligram fresh agar culture "Rio-yang" bacillus in 1 cubic centimeter salt solution.	"Tokyo I" anti-dysenteric serum, complement free.	Fresh normal horse serum.	Plate colonies after five hours.
1 c. c	None.	None	Innumerable.
1 c. c	0.1 c. c.	None.	Do.
1 c. c	None	0.2 c. c.	Thousands
1 c. c	0.1 c. c	0.2 c. c.	One thousand.
1 c. c	0.05 c. c.	0.2 c. c.	One hundred.
1 c. c	0.025 c. c.	0.2 c. c.	None.
1 c. c	0.01 c. c.	0.2 c. c.	One hundred.
1 c. c	0.005 c. c.	0.2 c. c.	One thousand.
1 c. c	0.0025 c. c.	0.2 c. c.	Thousands.
1 c. c	0.001 c. c.	0.2 c. c	Do.
1 c. c	0.0005 c. c.	0.2 c. c.	Innumerable.
1 c. c	0.00025 c. c.	0.2 c. c.	Do.
1 c. c	0.0001 c. c.	0.2 c. c.	Do.
Control, no bacilli	None	0.2 c. c.	None.
Control, no bacilli	0.1 c. c.	None.	Do.

The results obtained by the use of a fixed amount of homologous immune serum sufficient to bring about the destruction of a definite amount of culture of *B. dysenteriæ* in the presence of a sufficiency of complement are shown by Tables VIII and IX. These are the only

TABLE XI.—*Bacteriolysis of the fifteen types of dysentery bacilli with anti-dysenteric horse serum, "Tokio I" and "Shiga."*

Type	Dysentery bacilli marked according to their source	Mannite fermentation	Anti dysenteric serum, "Tokyo I" (acid). Bacteriolysis: 0	100-1	500-1	[illegible]	Limit of agglutination.	Anti-dysenteric serum, "Shiga" (non-acid). Bacteriolysis: [illegible]	[illegible]	[illegible]	Limit of agglutination
A	Shiga	Non acid					—(1-20)	--	+		1-1,000
B	Port Arthur						—(1-20)		+		1-1,000
C	Yalu						—(1-20)				1-1,000
D	Rio-yang II			+			1-100				1-4,000
E	Korea I						—(1-20)		+		1-1,000
F	Wakayama I						—(1-20)		--		1-1,000
G	Tokyo I	Acid					1-2,000	—	-		1-800
H	Korea II						1-1 000				1-2,000
I	Rio-yang I						1-500				1-1,000
J	Baltic II						1-2,000		—		1-500
K	Tokyo III						1-750				1-2,000
L	Yamaguchi						1-300				1-1,000
M	Tokio IV						1-1 000				1-500
N	Korea III						1-500				1-2,000
O	Kyoto						1-1 000				1-2 000

The last table, XI, shows that with anti-dysenteric horse serum the evidences of "cross bacteriolysis" between both types can also be obtained. If we omit the results with the "D" type (Rio-yang II, non-acid) we should be led to the wrong conclusion, namely, that cross bacteriolysis did not exist in the bacteriolysis with the anti-dysenteric horse serum of the "G" type (Tokyo I), thus would also be the case with the horse serum from "A" type (Shiga), and if, in these tests, we had not the results with "H" (Korea II) and "K" (Tokyo III) we would arrive at the same faulty conclusion. It therefore is apparent why bacteriolytic tests have frequently led various authors to conform to the opinions of Lentz. In Table XI we can also see the nonconformity of the fermentation and agglutination tests with the bacteriolytic reactions. We can observe the positive bacteriolysis of the non-acid type "D" (Rio-yang II) with anti-dysenteric serum from the acid type and the negative reaction of types "C" (Yalu) and "F" (Wakayama I) with the homologous—i. e., non-acid—anti-dysenteric serum from "A" (Shiga). A further study of Table XII will reveal a number of other cross bacteriolytic reactions and also many negative ones with the homologous anti-dysenteric sera. Among the latter we will also find that the "A" (Shiga) type shows no evidence of bacteriolysis by the anti-dysenteric rabbit serum "B" (Port Arthur)

From all these experiments we can conclude that bacteriolysis of the different strains *in vitro* may take place irrespective of the type, whether acid or non-acid, and also irrespective of whether the immune serum has been prepared with an acid or non-acid strain. On the basis of these facts, and in view of the results of the fermentation and agglutination tests, I must again emphasize that I can see no reason whatever for recognizing two distinct groups of bacilli as suggested by Lentz, namely, those which ferment mannite and those which do not, nor for distinguishing between the so-called "dysentery" and "pseudo-dysentery" bacilli as proposed by Kruse. Furthermore, these results are in conformity with those of Flexner, Strong, Gay, and other American authors, in showing that both types of dysentery bacilli have equal etiological importance and that the differences between them are unimportant.

In the preceding pages I have demonstrated that there are fifteen varieties of dysentery bacilli, nine of which ferment mannite and six of which do not. I have also proved that the separation of these varieties into two groups according to their power of fermenting mannite can not be made in conformity with their agglutinative and bacteriolytic reactions, and, in addition, I have endeavored to test the comparative agglutinative and bacteriolytic reactions of bacilli which have the same properties in regard to fermentation. Among the seventy-four strains of dysentery bacilli which have been isolated in Japan, Korea, Manchuria, from the Japanese and Baltic fleets, and in the Philippine Islands, four are of the "A" type ("Shiga"), six of the "L" type ("Yamaguchi"), and seven of the "I" type ("Rio-yang I"). As Tables XIII, XIV, and XV show, the several strains of the same type do not possess homologous agglutinative and bacteriolytic reactions against the homologous antidysenteric serum.

TABLE XIII.—*Agglutination and bacteriolysis of bacilli of the same type with "Shiga" ("A") with the same sera.*

Bacilli tested	"Port Arthur II"	"Gaiping I"	"Shiga."	"Philippine I."
Anti-dysenteric serum (rabbit serum)				
"Shiga" ("A" type, non-acid)—				
Agglutination	600	600	1,000	600
Bacteriolysis	—	0.005	0.001	-
"Kyoto" ("O" type, acid)—				
Agglutination	—(1-20)	—(1-20)	75	200
Bacteriolysis	0.01	0.005	0.001	—

TABLE XIV.—*Agglutination and bacteriolysis of bacilli of the same type with "Yamaguchi" ("L" type), with sera "B" and "O."*

Bacilli tested.	"Ari-maka."	"Kasu-yo."	"Okabe."	"Toya-ma."	"Yama-guchi."	"Odo-masa."
m (rabbit serum):						
"B" (non-acid)						
Agglutination	200	—(1-20)	—(1-20)	200	—(1-20)	—(1-20)
Bacteriolysis	—	0.0025	—	0.01	0.05	0.0005
"O" (acid)—						
Agglutination	800	—(1-20)	—(1-20)	20	20	—(0-20)
Bacteriolysis	0.005	—	0.005	0.0005	0 001	0.005

TABLE XV.—*Agulutination and bacteriolysis of bacilli in the same type with "Rio-yang I" ("I" type), with sera "B" and "O."*

Bacilli tested	"Ito."	"Iiji-na"	"Mori-shita"	"Miya-ke."	"Baltic I."	"Ota."	"Rio-yang I."
Anti-dysenteric serum (rabbit serum)							
"B" (non-acid)—							
Agglutination	40	80	80	80	40	—(1-20)	80
Bacteriolysis	—	0 01	0 0005	0 0025	0.025	0 025	—
"O" (acid)—							
Agglutination			200	40	(1 20)	20	
Bacteriolysis			—	—	0 01	-	

It is interesting to compare the reaction of "Port Arthur II" and "Philippine I" strains (see Table XIII). These organisms have the same properties in regard to fermentation as has the "Shiga" strain ("A" type), but they do not react with positive bacteriolysis to anti-dysenteric serum from the "A" type (Shiga). On the other hand, the "Port Arthur II" and "Gai-ping I," which behave like the "Shiga" ("A" type) in respect to fermentation, react with positive bacteriolysis to anti-dysenteric serum against "Kyoto" strain ("O" type). In addition, the "Philippine I" strain shows a high agglutination (1-200) but the "Shiga" only a low one (1-75) to this same serum. However, the Shiga organism shows a higher degree of bacteriolysis (0.001). This same phenomenon is not rare among the strains of two of the other types ("L" and "I"), as Tables XIV and XV show.

Tables XVI and XVII demonstrate that the same phenomena are obtained among selected strains of the same type, which show the same fermentative reactions during five days, and from these experiments we can conclude that even among strains of the same type in fermentation

TABLE XVIII.—*Cross bacteriolysis of six types of dysentery bacilli tested with homologous sera.*

Sera and type.	Non-acid bacilli. "A."	"D."	"F."	Acid bacilli. "G."	"H."	"O."
Non-acid sera.						
"A"	+	+	-	-	+	[illegible]
"D"	-	-	-	+	[illegible]	+
"F"	-			+	+	-
Acid sera.						
"G"		[illegible]	+	+	+	-
"H"	+	[illegible]	+	[illegible]	-	+
"O"	+	[illegible]	-	-	+	+

SUMMARY AND CONCLUSIONS.

In order that complete observations might be obtained, 74 strains of dysentery bacilli were isolated, collected, and identified from several sources, Japan, Korea, Manchuria, the Philippine Islands, and the Japanese and Baltic fleets (during the Russo-Japanese war). Upon a comparison of all these strains it was found that they could not be distinguished from one another either by their morphological or cultural properties, although minor differences were shown to exist in their fermentative powers and their reaction toward immune serum.

In my experiments I was not satisfied in attempting a differentiation of the different types of bacilli, based on the fermentation and agglutination reactions alone, but in addition their bacteriolytic action toward immune sera was employed.

(1) The results of the study indicate that the great majority of the bacilli which have been isolated during the past few years from cases of acute dysentery (not due to amœbæ) must be considered as being the exciting factor of the disturbance. The organisms which have come into my possession and which have been isolated as the cause of dysentery may be separated into fifteen groups which have fermentative characters distinguishing them one from the other, six not fermenting, and nine fermenting mannite (so called non-acid and acid bacilli.)

(2) The mannite fermenting types are widely scattered over the world and certainly cause characteristic sporadic cases and epidemics of dysentery. The form of the disease caused by them is often severe. On the other hand, the non-fermenting ones often give rise to milder cases of infection (as in Manchuria).

(3) The grouping of the different organisms, according to the differences in their powers of causing fermentation, does not correspond to that which results from differences observed in agglutinative and bacteriolytic action with specific immune sera. The anti-dysenteric rabbit

sera, prepared with so-called non-fermenting bacilli, often agglutinate strains which ferment mannite in the same or in higher dilutions than they do other organisms of the non-fermenting type, and vice versa. The same phenomena can also be confirmed by bacteriolytic tests, the so-called "cross bacteriolysis" usually taking place between bacilli termed both acid and non-acid.

(4) In consideration of all the above facts it seems to me that no reason exists to separate the dysentery bacilli into two distinct groups, the acid and non-acid, as proposed by Lentz, and I can also see no justification in designating any bacillus which causes dysentery as a "pseudo-dysentery bacillus" according to Kruse. We are compelled to consider the fifteen types of dysentery bacilli as constituting a single group.

Finally, I take great pleasure in acknowledging my indebtedness to Professor Kitasato, director of the Government Institute for Infectious Diseases in Tokyo, for many suggestions and kindnesses; I am also under obligations to Dr. Shiga for important suggestions and kind assistance. I desire also to express my obligations to Dr. Strong, director of the Biological Laboratory, Bureau of Science, Manila; Dr. Momose and Dr. Hirano, naval fleet surgeons of the Imperial Japanese Navy, and Dr. Hata and Dr. Oshida, military lieutenant surgeons of the Imperial Japanese Army for courtesies shown by them in sending me materials for this study. My thanks are also due to Dr. Hidaka for assistance in my experiments.

REFERENCES.

(1) Flexner: On the Etiology of Tropical Dysentery. *Phila. Med. Journ.* (1900), VI, 414. Also *Bull. Johns Hopkins Hosp* (1900), XI, 231.

(2) Strong: Ibid *Phila. Med. Journ.* (1900), VI, 423. Etiology of the Dysenteries of Manila. *Circulars on Tropical Diseases*, Manila, I and II (1901).

(3) Strong and Musgrave: *Rep. Sur.-Gen. Army, Wash.* (1900). Abstract in *J. Am. Med. Ass.* (1900), XXXV, 498 and 501.

(4) Kruse: Ueber die Ruhr als Volkskrankheit und ihren Erreger. *Deutsche med. Wchnsch.* (1900), XXVI, 637.

(5) Kruse: Weitere Untersuchungen über die Ruhr und die Ruhr bacillen. *Ibid* (1900), XXVII, 370 and 386.

(6) Spronck: Eine kleine Epidemie von Pseudo dysenteriæ bacillaris zu Utrecht. *Baumg. Jahresb.* (1901), XVII, 473 (1902), XVIII.

(7) Flexner: A Comparative Study of Dysenteric Bacilli. *Centrbl. f. Bacteriol.* (1901), XXX, 449.

(8) Vedder and Duval: The Etiology of Acute Dysentery in the United States. *J. Exp. Med.* (1902), VI, 181. Also *Centrbl. f. Bakteriol.* (1902), XXXI, 148.

(9) Duval and Basset: The Etiology of Summer Diarrhœas of Infants. *Centrbl. f. Bakteriol.* (1902), XXXIII, 52. Also *Am. Med* (1902), IV, 417.

(10) Park and Dunham: A clinical and bacteriological study of a number of outbreaks of Disease due to the Dysentery Bacillus of Shiga. *N. York Univ. Bull. Med. Sci.* (1902), 187.

A LIST OF PHILIPPINE CULICIDÆ WITH DESCRIPTIONS OF SOME NEW SPECIES.

By Charles S. Banks.

(From the entomological section, Biological Laboratory, Bureau of Science.)

The mosquito problem in its relation to human pathology has assumed such gigantic proportions in all parts of the world during the past decade, and species and genera have been found in such large numbers, especially throughout tropical regions, that little wonder attaches to the discovery of a very great number of species within a comparatively brief period in the Philippines. Osten-Sacken, in his "Diptera from the Philippine Islands, brought home by Dr. Carl Semper,"[1] gives:

Culex, several species, damaged

Megarhina, one male; determined by Walker as *M. immisericors* Wk., although abdomen and legs do not agree with his description. It may be *amboinensis* Dol., although the agreement is not perfect

Padre Casto Elera[2] gives in addition *Culex pipiens* Linn., as occurring in all parts of the Archipelago and *Corethra manilliensis* Schiner,[3] so that up to the year 1895 the knowledge of just what species of *Culicida* occur in the Islands was, to say the least, very indefinite.

The work of the surgeons of the United States Army in various parts of this region brought under their observation many forms with which they were not familiar, and naturally they were led to send them to persons whose knowledge of the group would enable them to identify the species found and give the physicians working here some idea as to the possible prevalence of pathophoric forms. Among those who have done most in the matter of identification of material are Professor F. V. Theobald, Lieutenant-Colonel George M. Giles, I. M. S. (retired), and Miss Clara S. Ludlow, the latter of the laboratory of the Surgeon-General's Office, United States Army, at Washington. They have also described many new species from the Philippines, and it is therefore but natural that in compiling a list of this kind I should have been very dependent upon their publications.

[1] *Berl. Ent. Ztschr.* (1882), 26, 96.

[2] *Catalogo de toda la Fauna Filipina* (1895), 2, 490, 491.

[3] *Reise der Novara, Diptera* (1868), 30.

In my own work with mosquitoes I have already been able to collect in hitherto unexplored regions several new species which will be added to the already long list, and I feel sure that others will be discovered in the material now on hand. Aside from the new species and one new genus, forms not indicated by any of the above-mentioned workers as occurring in these Islands have been collected, both in Manila and in the southern provinces, as will be seen by consulting the bibliography given with each species. No claim can be made for completeness of reference in all cases, but I believe that, with few exceptions, the works I have cited give original descriptions. Where such are not given it was due to lack of literature, a feature not always to be avoided in the Antipodes.

In all, 83 species, subspecies, and varieties, including 7 as new species or varieties, are enumerated, embraced in 30 genera in 6 subfamilies. The Entomological Collection contains probably 8 as yet unidentified species, so that the total number will soon be not far from 95 per cent of the number of species found in the United States and, as very little work has been done in higher altitudes, the number of species will, within the next five years, probably be considerably further increased.

An interesting and valuable feature of the work being done on Philippine mosquitoes is the study of their life histories and habits. A great diversity of habits, constant for members of a given species, is to be found among those so far studied.

The form described in this paper as *Stegomyia fasciata persistans* Banks is of very great interest. It was at first supposed to be and identified as *S. fasciata* Fabr., by me, the material in each case having been collected rather than reared. Later breedings developed a form so unlike the descriptions of *S. fasciata* Fabr., that doubt arose as to the previously identified specimens being *S. fasciata* Fabr., although Theobald and Ludlow had both reported *S. fasciata* Fabr., from almost the identical regions where the aberrant form was found. Great care was exercised in mounting, and all specimens collected or bred were subjected to examination, so that not less than 2,000 have passed beneath my lens. Not a single individual was found among the perfect specimens, namely, those in which the mesothorax was not in the least denuded, which did not display ornamentation quite different from the descriptions of *S. fasciata* Fabr. Unfortunately, it has not been possible for me to examine in recent years a specimen of the true *S. fasciata* Fabr., so that I have been obliged to depend upon the very careful descriptions given by Theobald. Because of the character of his descriptions I feel all the more assured in taking the stand that the form found here, while closely approaching the type, differs from it sufficiently to be considered a subspecies, the *constancy of ornamentation* in the Philippine form being also a feature in favor of separating it as distinct. If this subspecies proves to be distinct from *S. fasciata* Fabr., and provided that *S. fasciata* Fabr., can not be demonstrated as being in the Islands, the importance of its

11. MYZORHYNCHUS BARBIROSTRIS Van der Wulp—Continued.
Myzorhynchus barbirostris V. d. W., Theobald, *Ibid.* (1903), **3**, 86.
——— ——— — — — Ludl., *Can. Ent.* (1905), **37**, 135.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*); RIZAL, Manila waterworks, Camp 320, P. I. (5205 *Banks, Schultze*); MANILA, P. I. (5762 *Banks*); FT. MCKINLEY, P. I. (5783 *C. F. Craig*).

12. MYZORHYNCHUS PSEUDOBARBIROSTRIS Ludl., *J. N. Y. Ent. Soc.* (1902), **10**, 127.
— — — ——— Theob., *Gen. Ins., Culic.* (1905), 10.
— — — — — — — — *Can. Ent.* (1905), **37**, 135.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

13. MYZORHYNCHUS SINENSIS Wied.
Anopheles sinensis Wied., *Aussereurop. Zweifl. Ins.* (1828), 547.
— Theob., *Mono. Culic.* (1901), **1**, 137, Pl. XXXVII, fig. 146, & Pl. A.
— Giles, *Handb. of Gnats* (1902), 305.
Myzorhynchus sinensis Wied., Theob., *Mono. Culic.* (1903), **3**, 89.
— Giles, *J. Trop. Med.* (1904), **7**, 365.
— ——— Theob., *Gen. Ins., Culic.* (1905), 10.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

14. MYZORHYNCHUS VANUS Walker.
Anopheles vanus Walker, *J. Proc. Linn. Soc. Lond.* (1860), **4**, 91.
Anopheles sinensis annularis Theobald, *Mono. Culic.* (1901), **1**, 142.
Myzorhynchus sinensis annularis Theobald, *Ibid.* (1903), **3**, 90.
— ——— ——— — — — *Gen. Ins., Culic.* (1890), 10.

PANGASINAN, Camp Gregg, Bayambang, P. I. (*W. P. Chamberlain*). MANILA, P. I. (3723, 3800 *R. C. McGregor*) (4553 *P. G. Woolley*).

NYSSORHYNCHUS Blanchard (10).

15. NYSSORHYNCHUS FULIGINOSUS Giles.
Anopheles fuliginosus Giles, *Handb. of Gnats* (1900), 1st ed., 160.
— — — jamesii Liston, *Ind. Med. Gaz.* (1901), 441.
leucopus Dönitz, *Insekten Borse* (1901), **5**, 37.
— fuliginosus Giles, Theob., *Mono. Culic.* (1901), **1**, 132, Pl. 1, fig. 3.
Handb. of Gnats (1902), 2d ed., 298.
Nyssorhynchus fuliginosus Giles, Theob., *Mono. Culic.* (1903), **3**, 93.
— Ludl., *Can. Ent.* (1905), **37**, 135.

PANGASINAN, Bayambang, P. I. (*W. P. Chamberlain*).

16. NYSSORHYNCHUS PHILIPPINENSIS Ludl.
Anopheles philippinensis Ludl., *J. Am. Med. Assn.* (1902), **39**, 426.
— . *J. N. Y. Ent. Soc.* (1902), **10**, 128.
Nyssorhynchus philippinensis Ludl., Theob., *Gen. Ins., Culic.* (1905), 10.

ABRA, San José, P. I.

CELLIA Theobald.

17. CELLIA KOCHII Dönitz.
Anopheles kochii Dönitz, *Insekten Borse* (1901), **5**, 18.
— — Theob., *Gen. Ins., Culic.* (1905), 11.

Federated Malay States, Sumatra, Java, Philippines.

II. MEGARHININÆ Theobald.

MEGARHINUS Robineau-Desvoidy (1).

18. MEGARHINUS AMBOINENSIS Dolesch., *Nat. Tijdsch. Ned. Indie* (1864), 14, 381.
-- -- -- Osten-Sacken, *Berliner Ent. Ztschr.* (1882), 26, 96.
-- -- -- Elera, *Cat. de toda la Fauna Filip.* (1895), 2, 490.
-- -- Giles, *Handb. of Gnats* (1902), 276.
-- -- Theob., *Gen. Ins., Culic.* (1905), 13.

Osten-Sacken says that *M. immisericors* may be *M. amboinensis* and Padre Elera gives it as distinct.

19. MEGARHINUS LEWALDII Ludl., *Can. Ent.* (1904), 36, 233.
GUIMARAS ISLAND, Salog, P. I. (*L. I. Le Wald*)

III. TOXORHYNCHITINÆ Theobald.

TOXORHYNCHITES Theobald (1).

20. TOXORHYNCHITES IMMISERICORS Walk.
Megarhinus immisericors Walk. *J. Proc. Linn. Soc. Lond.* (1860), 4, 91.
regius Thwaites, *Idem* (1861), 8, 102.
— subulifer Doleschall, *Nat. Tijdschr. Ned. Ind.* (1864), 14, 382.
Megarhina immisericors Walker, *J. Proc. Linn. Soc. Lond.* (1865), 9, 7.
Megarhinus immisericors or amboinensis, Dol., Osten Sacken, *Berl. Ent. Ztschr.* (1882), 26, 96.
Megarhina immisericors Walk., Elera, *Cat. de toda la Fauna Filip* (1895), 2, 490.
Megarhinus immisericors Walk., Theob., *Mono. Culic.* (1901), 1, 225.
-- gilesii Theob., *Idem.* (1901), 227.
immisericors or amboinensis, Dol., Giles, *Handb. of Gnats* (1902), 273.

Ceylon, India, Malay Peninsula, and East Indies.

Osten Sacken says "one ♂ determined by Walker as *M. immisericors* Walk., although abdomen and legs do not agree with his description. It may be *amboinensis* Dol., although the agreement is not perfect." Padre Elera copies the two species mentioned by Osten Sacken as each being found in the Philippines.

WORCESTERIA Banks (2).

21. WORCESTERIA GRATA Banks, *Phil. Journ. Sci.* (1906), 1, 780.

NEGROS OCCIDENTAL, Bago, P. I. Hacienda "Louisiana," Mailum (6071 *Banks*); CEBU, Cebu, P. I. (5726 *McGregor*).

HULECOETOMYIA Theobald (12).

42. HULECOETOMYIA PSEUDOTAENIATA Giles.
Stegomyia pseudotaeniata Giles, *The Entom.* (1901), 192.
— — — — — Theob., *Mono. Culic.* (1901), 1, 312, fig. 312.
— — — *Handb. of Gnats* (1902), 379.
— — — — — Theob., *Gen. Ins., Culic.* (1905), 20.

India; RIZAL, Manila waterworks, Gorge Camp, P. I. (5596 *Banks*).

This is the first record of this species as from the Philippine Islands. I bred the specimens under conditions similar to those mentioned by Giles. It was common in January at the locality cited.

GRABHAMIA Theobald (21).

43. GRABHAMIA SPENCERII Theob.
Culex spencerii Theob., *Mono. Culic.* (1901), 2, 99.
— — — Giles, *Handb. of Gnats* (1902), 431.
Grabhamia spencerii Theob., *Mono. Culic.* (1903), 3, 250.
— — — *Gen. Ins., Culic.* (1905).

Canada, Idaho; PHILIPPINE ISLANDS.

This is evidently quoted as from the Philippines in error in "Genera Insectorum"

CULEX Linnaeus (24).

44. CULEX ANNULIFERUS Ludlow.
annulifera Ludlow, *J. N. Y. Ent. Soc.* (1903), 2, 141
annuliferus Ludlow, *Can. Ent* (1904), 36, 72.
annulifera Ludlow, *Ibid.* (1904), 36, 299.

PANGASINAN, Camp Gregg, Bayambang, P. I (*W. P Chamberlain*)

45. CULEX CONCOLOR Desvoidy, *Mem. de la Soc. d'Hist. Nat. de Paris* (1825), 4, 405.
Theob., *Mono. Culic.* (1901), 2, 107, Pl. XXVIII, figs. 109, 110
— Giles, *J. Trop. Med.* (1904), 7, 368.
— — — Theob., *Gen. Ins., Culic.* (1905), 29

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

Theobald states that the genus relation of this species is still uncertain.

46. CULEX FATIGANS Wiedmann, *Aussereurop. Zweifl. Ins.* (1828), 10
Culex aestuans Wied., *Ibid.* (1828).
— — purgens Wied., *Ibid.* (1828), 9.
— pallipes Meigen, *Syst Beschr., Supp.* (1838).
— — anxifer Coquerel (Bigot), *Ann. Soc. Ent. Fr.* (1859), 112.
Heteronycha dolosa Arribalzaga, *Dipt. Argent.* (1896), 56.
Culex macleayi Skuse, *Proc. Linn. Soc. N. S. Wales* (1896), 1745.
Culex skusei Giles, *Handb. of Gnats* (1900), 292
— — Theob., *Mono. Culic.* (1901).
— — Giles, *Handb. of Gnats* (1902), 438
— — Theob., *Mono Culic.* (1903), 3, 225.
— — Theob., *Gen. Ins., Culic.* (1905), 28.

TAENIORHYNCHUS Arribalzaga (25).

60. **Taeniorhynchus argenteus** Ludlow, *Can. Ent.* (1905), **37**, 98.
PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

61. **Taeniorhynchus lineatopennis** Ludlow, *Can. Ent.* (1905), **37**, 133.
PANGASINAN, Bayambang, P. I. (*W. P. Chamberlain*).

62. **Taeniorhynchus whitmorei** Giles, *J. Trop. Med.* (1904), **7**, 367.
PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

MANSONIA Blanchard (26).

63. **Mansonia annulifera** Theobald.
Panoplites annulifera Theob., *Mono. Culic.* (1901), **2**, 183, Pl. XXX, fig. 120, text fig. 224.
——— Giles, *Handb. of Gnats* (1902), 356.
Mansonia annulifera Ludlow, *Can. Ent.* (1904), **36**, 299; (1905), **37**, 734.
—— *Gen. Ins., Culic.* (1905), 32.

India, Ceylon, Federated Malay States; PANGASINAN, Bayambang, P. I. (*W. P. Chamberlain*); PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*); MANILA, P. I. (2715, 4214, 5734 *Banks*) (4114 *G. L. Araneta*).

64. **Mansonia annulipes** Walker.
Culex annulipes Walker, *Proc. Linn. Soc. Lond.* (1857), **1**, 5.
dives Schiner, *Reise der Novara, Diptera* (1868), 31.
—— nero Doleschall, *Nat. Tijdsch. Ned. Ind.* (1864), **14**, 383.
annulipes Walker Theob., *Mono. Culic.* (1901), **2**, 185, fig. 119; (1903), **3**, 275, Pl. XXX.
Theob., *Gen Ins., Culic.* (1905), 32.

Straits Settlements, Java; MINDORO, Rio Baco, P. I. (3289 *R. C. McGregor*).

65. **Mansonia uniformis** Theobald.
Panoplites uniformis Theob., *Mono. Culic.* (1901), **2**, 180, Pl. XXX, fig. 118.
Mansonia africanus Theob., *Mono. Culic.* (1901), **2**, 187.
,, australiensis Theob., Giles, *Handb. of Gnats* (1902), 2d ed., 355 (Ms.).
Panoplites uniformis Theob., Giles, *Handb. of Gnats* (1902), 253.
Mansonia uniformis Theob., Ludlow, *Can. Ent.* (1905), **37**, 134.

India, Ceylon, Federated Malay States, central and western Africa; PANGASINAN, Bayambang, P. I. (*W. P. Chamberlain*); MANILA, RIZAL, Ft. McKINLEY (5207 *Banks, Schultze*) (5751 *Mrs. W. R. Banks*) (5770, 5781 *C. F. Craig*) (5842 *G. L. Araneta*).

This is the most abundant of the *Mansoniæ*, being very troublesome at times in Ft. McKinley and Manila.

FINLAYA Theobald (29).

66. **Finlaya aranetana** Banks, sp. nov., *Phil. Journ. Sci.* (1906), **1**, 1001.
NEGROS OCCIDENTAL, Bago, P. I., Hacienda "Louisiana," Mailum (6066, 6085 *Banks*); MANILA, P. I. (5772 *Banks*).

67. FINLAYA FLAVIPENNIS Giles, *J. Trop. Med.* (1904), 7, 366.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

68. FINLAYA MELANOPTERA Giles, *J. Trop. Med.* (1904), 7, 367.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

69. FINLAYA POICTLIA Theobald, *Mono. Culic.* (1903), 3, 283.

— — — Giles, *J. Trop. Med.* (1904), 7, 366.

— — *Gen. Ins., Culic.* (1905), 33.

Quoted in error as *F. poicilia* Theob., Giles, *J. Trop. Med.* (1904), 7, 366.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*); NEGROS OCCIDENTAL, Bago, P. I., and Mailum at Hacienda "Louisiana" (6008 *Banks*).

ANISOCHELEOMYIA Ludlow (*Incerta sedis*).

70. ANISOCHELEOMYIA ? ALBITARSIS Ludlow, *Can. Ent.* (1905), 37, 131.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

POPEA Ludlow (*Incerta sedis*).

71. POPEA LUTEA Ludlow, *Can. Ent.* (1905), 37, 96.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

REEDOMYIA Ludlow (*Incerta sedis*).

72. REEDOMYIA PAMPANGENSIS Ludlow, *Can Ent.* (1905), 37, 94.

PAMPANGA, Angeles, P. I. (*E. R. Whitmore*).

VI. AEDEOMYINÆ THEOBALD.

(*Aedinæ* Blanchard.)

AEDEOMYIA Theobald (2).

73. AEDEOMYIA SQUAMMIPENNA Arribalzaga.

Aedes squammipennis Arrib., *El Nat. Arg.* (1878), 1, 151, 3.

squammipenna Arrib., *Dipt. Arg.* (1891), 62.

Aedeomyia squammipenna Arrib., Theob., *Mono. Culic.* (1901), 2, 219; (1903), 3, 307.

squammipennis Giles, *Handb. of Gnats* (1902), 479.

— squammipenna Arrib., Theob., *Gen. Ins., Culic.* (1905), 35.

South America, West Indies, Ceylon, India, Federated Malay States, Sudan; PHILIPPINES, MANILA, P. I. (4464, 5758 *Banks*) (4661 *Schultze*) (5208 *P. G. Woolley*).

Found in numbers at Manila.

URANOTAENIA Arribalzaga (4).

74. URANOTAENIA CAERULEOCEPHALA LATERALIS Ludlow, *Can. Ent.* (1905), 37, 385.

MINDANAO, Cotabato, P. I. (*E. B. Vedder*).

75. **Uranotaenia falcipes** Banks, sp. nov., *Phil. Journ. Sci.* (1906), 1, 1004.

RIZAL, waterworks, Camp 320, Manila, P. I. (5210 *Banks, Schultze*).

76. URANOTAENIA NITIDOVENTER Giles, *J. Trop. Med.* (1904), 7, 368.

PAMPANGA, Camp Stotsenberg, Angeles, P. I. (*E. R. Whitmore*).

at apex of second segment; fourth and fifth if divided into three equal areas would be cream-scaled in the first or basal and third or apical areas and black-brown-scaled in the second. The apical would be very slightly longer, owing to the tuft of cream scales at tip. Proboscis uniformly dark-brown-scaled, the tip being scaleless, lighter brown, and bristled.

Prothoracic lobes dark-brown, clothed with narrow scales and bristles; mesothorax with broad, grey, median area, bordered by brown and with sparse, golden, curved, hair-like scales; a very much elongated narrow, dark V-mark extends from the prothoracic lobes across grey median area, meeting the apex of an acute triangular brown spot at posterior margin; scutellum simple and sparsely covered with golden hair-scales; metanotum nude, brown; halteres ocher, dark-knobbed.

Legs quite uniform brown; femora lighter basally; tibiæ somewhat swollen apically and truncated; metatarsi and tarsi dark-brown; in some lights the last tarsi of posterior legs appear light-brown and the bases of all tarsal segments are lighter.

Abdomen a uniform dark-brown, with golden hair scales; the basal ventral segments slightly lighter.

Wings cream, spotted with brown as follows: Four prominent large brown spots on costa, beside 2 small basal and 1 at extreme apex on curve of wing. The 4 large ones are: First 1½ times its own length from base of wing and occupying costa, subcosta, and Vein I equally; second, which is largest, ½ its own length from first and occupying costa and subcosta equally, but on Vein I its second quarter is cream, much as in *M. ludlowii* Theob.; third spot its own length from second and occupying costa and Vein I equally; fourth its own length from third and occupying costa and Vein I. The extreme apical tiny spot referred to above is 5 times its own length from costal spot 4, lying between forks of first submarginal cell. Vein II with brown on each side of cross vein, its anterior fork with 2 spots lying below costal spots 3 and 4, respectively; its posterior fork all brown except extreme base and apex: Vein III with brown spot near base and very tiny spot near apex; Vein IV brown from opposite costal spot 1 to near mid cross vein, then cream, then its entire stem brown with base of forking cream; its anterior fork all brown except slight cream at base and apex; its posterior fork with long brown spot in middle; Vein V with small brown spot near base and at its forking; its anterior fork with 3 long, brown spots, the middle one longest; posterior fork cream on basal, brown on apical half, except cream spot at junction with margin. Vein VI with basal half, cream except a small spot at its middle; apical half brown, not reaching margin. Marginal fringe brown-slate with slight cream near base and cream interruptions at forks of Veins IV and V and at apex of Vein III.

♂ of this species unknown.

MINDORO, Rio Baco, Chicago, P. I. (*R. C. McGregor*, Coll.)

Time of capture, 7 May, 1905, in early morning, the majority of the specimens, all of which are females, being gorged with blood.

Type ♀, No. 3290 in Entomological Collection, Bureau of Science, Manila, P. I.

This mosquito bears a strong superficial resemblance to *M. ludlowii* Theob., except that it is very much smaller and there is a very decided difference in the spotting of the wings.

The species is named from a tribe of semi-civilized peoples inhabiting the interior of Mindoro and known as the Mangyanes.

PYRETOPHORUS FREERÆ, sp. nov.

Small, dark-grey, with light-grey, lanceolate thoracic scales, and golden, hair-like abdominal scales; fore and mid legs with banded tarsi; posterior tarsi snow-white; palpi dark-brown, white tipped and narrowly white banded before apex; a few white hairs at middle of palpi; frontal tuft white and nearly as long as head; antennæ pale-brown, with white hairs.

♀, length 3.25 millimeters; length of wing 2.75 millimeters; length of proboscis 1.5 millimeters; dark-grey; head with posterior black and anterior white, upright, forked scales; several incurving, black bristles posterior to eyes on sides of head; frontal tuft of pure-white, recurved bristles, nearly as long as head; eyes black; antennæ pale-brown with whorls of snow-white bristles and fine, silvery pubescence; palpi equal in length to proboscis, densely black scaled, those basally being semi-erect; a small tuft of 3 or 4 silvery scales at middle dorsally; apex broadly silver-tipped with few scattered brown scales; a narrow, silver band before apex, separated from apical white by a broad black area equal in length to white apex; proboscis entirely dark-brown, tipped with golden scales at apex.

Prothoracic lobes dark-grey with few, white, flat scales; mesonotum dark-grey with indistinct, longitudinal, darker areas; median region clothed with very pale-golden, bluntly lanceolate, flat scales; external to this region the notum is comparatively bare; pluræ sparsely white-scaled; metanotum dark-brown, nude; scutellum with white scales on all lobes.

Abdomen dark-brown-grey, clothed with pale-golden hair-like scales more abundant toward posterior extremity; lamellæ with dark-brown, flat, somewhat truncated scales and a few, long, golden bristles; under surface sparsely clad with white hairs.

Halteres white, black-knobbed.

Legs pale to dark, golden-brown, banded and white-tipped; anterior femora, dark basally, much lighter apically, with a dark spot before knee; mid femora light basally, dark apically with an external white spot before knee; and an internal, longitudinal, pale line; posterior femora uniformly dark-brown above and externally, lighter brown-golden internally and basally; all tibiæ uniformly dark-brown above, the mid and posterior ones having an external, paler, longitudinal line for their entire

length; the posterior tibiæ swollen apically and white-tipped; all metatarsi uniformly dark-brown, on the anterior and mid, broadly on the posterior narrowly white at apex; anterior and mid tarsi very dark-brown, the first and second segments, only, white tipped; posterior tarsi snow-white except basal half of first segment which is dark-brown.

Wings yellow and brown spotted as follows: Costa with 7 dark-brown spots, the basal being the shortest, the second, third and fourth successively longer, the fifth twice length of fourth, from which it is removed by a yellow area equal in length to second dark spot; sixth slightly shorter than fifth from which it is separated by a distance equal to that between fourth and fifth; seventh equal in length to fourth and separated from sixth by its own length. Subcosta with spots similar to 4 and 5 of costa, except that the one below 5 has some yellow scales at its beginning; Vein I with spot under 4 of costa, 3 spots under 5, a small one at beginning a large one in middle and a very small one at end, similar to those of *Myzomyia ludlowii* Theob., in position; a spot under 6 and 7 of the costa; Vein II with 3 dark spots on stem, one before and two after supernumerary, a basal and an apical dark spot on its anterior and a basal, a median and an apical spot on its posterior fork; Vein III with a dark spot on each side of mid cross vein and one apically, the portion before mid cross vein, dark scaled, the stem of its forks being yellow basally, the remainder being dark to fork, its anterior and posterior forks each with 2 darks spots; Vein V with a yellow spot at extreme base, then with a dark spot of same length followed by yellow to apex of posterior fork which is dark, its anterior fork having 3 dark spots, two sub-basal and the other apical; Vein VI with 3 dark spots, one sub-basal, a faint one medial and one apical. Cilia, beginning at apex of wings, alternately yellow and brown turning to grey-brown or nearly white near base.

Mid cross vein slightly more than its own length from supernumerary, the posterior cross vein slightly more remote from mid cross vein.

The unscaled portions of wing membrane have a golden sheen which is quite noticeable.

♂ unknown.

MANILA, P. I. (*Banks*, collector).

Time of capture 23 October 1906.

Type ♀, No. 5975 in Entomological Collection, Bureau of Science, Manila, P. I.

This striking species is at once distinguishable by its snow-white hind tarsi, its frontal tuft and thoracic scales, from any other Anophelinæ in the vicinity of Manila.

It is dedicated to Mrs. Paul C. Freer through whom I was led to discover the first specimen of this species seen. This specimen escaped, but the second one, from which this description is made, was caught in my house at the light. The type lacks the mid left leg.

CULICINÆ.

STEGOMYIA AUROSTRIATA, sp. nov.

Head with black-brown and white scales, thorax brown with golden stripes, abdomen dark-brown, light, almost white ventrally; legs dark-brown except femora which are pale.

♀, length 5 millimeters; length of wings 3.5 millimeters; length of proboscis 2.5 millimeters; head covered with broad, flat scales, nearly white, pale-yellow around eyes and broadly in the median and occipital regions; a broad, black patch on either side giving appearance of eyes when viewed from above; a few scattered, upright, dull-grey, forked scales above nape; lateral curved bristles project forward over eyes; cheeks and under cephalic surface pale-yellow; antennæ brown, first segment paler, clothed on internal surface with patch of white scales as is also second segment very slightly; clypeus well developed, having a slight median depression, bare, but with slight pruinescense; palpi short, not ⅛ length of proboscis, 5-jointed, the ultimate being extremely minute and globose; proboscis dark-brown, slightly swollen at apex which is lighter red-brown.

Prothoracic lobes large, covered with a patch of golden, flat scales and a bunch of rather stout bristles; mesothorax with dark-seal-brown, narrow scales and adorned as follows: A very narrow, golden median line, scarcely perceptible anteriorly, extending from anterior to posterior margin where it dilates to cover the area of the usual bare spot; external to this a broad, golden band, curving outward on each side of the anterior half and slightly inward on the posterior half of the dorsal area, the two being parallel posteriorly, and suggesting the lyre-figure of *S. fasciata* Fabr. External to these lines and anterior to base of wing a faintly suggested, longitudinal stripe of golden scales. Pluræ and coxæ with numerous patches of broad, dirty-white scales. Mid lobe of scutellum with median patch of flat, yellow-white scales bordered by dark-brown ones and with 4 large bristles; lateral lobes with few mixed yellow, white and brown scales and 3 large bristles each; metanotum bare, dark-brown; halteres pale-yellow with dark-brown knobs.

Abdomen above, very dark seal-brown, black in certain lights; posterior margins of segments with golden bristles; bases of fifth and sixth with narrow white bands, while all segments except last show triangular white patches laterally at their bases; venter white-scaled, except last two segments, which are black or dark-brown.

Legs mostly dark-brown; anterior femora brown internally except near base which is cream-white internally and externally, with a fine, cream-white line extending to knee-joint; mid femora similarly marked except for pale area externally at base and having fine, cream-white line internally; knees white, posterior femora all cream-white except a longitu-

The size in both ♂ and ♀ is extremely variable, specimens of the former measuring from 3.5–5 millimeters and of the latter 4–6 millimeters. Wing length ♂ 1.75–2.25 millimeters; ♀ 2–2.75 millimeters.

MANILA, NEGROS OCCIDENTAL, ILOILO, P. I. (*Banks*, Coll.).

Time of flight: This mosquito has been captured in Manila during every month of the year.

Types of ♂ and ♀ No. 5773 in Entomological Collection, Bureau of Science, Manila, P. I.

This mosquito is the most annoying form found in the Islands and like its congener, *S. fasciata* Fabr., is extremely persistent in its attacks, returning repeatedly however many times it may be repulsed. Upon alighting it walks around to find a suitable place to bite, its favorite points of attack being the back of the neck, the ankles, and the back of the hands when one is holding a book. It will in no case alight upon white articles except such as one may be wearing, such as white socks or white clothes that have been recently removed from the person. Its time of attack is from 1 to 3 p. m. and just as night falls, when the daylight is too dim for reading. It appears also to be a forerunner of a storm, as it usually attacks one with great energy just before signs of a shower appear. This mosquito is very wily, usually attacking one from behind, and when struck at, almost invariably flies behind one's chair to renew the attack as soon as everything appears to be quiet. This is not noticeable with any other species of mosquito so far observed in the Philippines.

CULEX LUTEOLATERALIS Theob.

CULEX LUTEOLATERALIS Theob., *Mono. Culic.* (1901), 2, 71 and Pl. XXVII, fig. 108.
——— *Gen. Insectorum, Culicida:* (1905), 27.
——— Giles, *J. Trop. Med* (1904), 7, 368.

The Philippine specimens of this mosquito differ from the type by the presence in the ♀ of two parallel, submedian, orange-golden striæ on the mesothorax for its entire length. In the ♂ these stripes are from about the middle to the posterior margin only. The palpi are destitute of any orange scales at the base. Mention should also be made of the fine, golden hairs interspersed among the flat scales of the dorsum of the abdomen and the greenish tinge of the cream-yellow basal bands. It could hardly be said of the Philippine specimens that the hind ungues are nearly straight, rather that they are straighter than in most species of *Culex* and with the tip sharply curved.

A notable feature of this species is the difference in appearance of the ♂ and ♀ wing-scaling. In the former the scales both median and lateral are certainly reduced almost to a minimum, there being never more than 8 on Vein VI for instance, and these lie exactly median, end upon end, while the same is true of Veins II, III, IV and V except that there are some 5 or 6 elongated lateral scales at the end of Vein III and

Prothoracic lobes large, rounded, with a small, oblong patch of golden-yellow scales: mesothorax brown, covered with long, narrow, brown scales and adorned as follows: A narrow, golden median line from anterior margin halfway through posterior bare brown spot; external to this at each side on anterior half, another short golden line; externally on posterior half a golden loop beginning at base of bare spot running forward parallel with median line, curving outward and backward, then parallel with itself, ending above root of wing; a patch of cream colored hairs anterior to root of wing and several patches on pleuræ; a median golden patch, lateral brown patches and 4 to 6 bristles on median lobe of scutellum; a few long, narrow, brown scales on lateral lobes, with many long, brown bristles; metanotum brown, bare; halteres pale with dark-brown and white scales on knobs.

Wings with dark-purplish-brown scales, those of posterior fringe being lighter drab-brown; *two golden-brown spines spring from near base of Vein 1.* Posterior cross vein twice its length from mid cross vein which is colineal with the supernumerary. First submarginal longer and narrower than second posterior, both of its veins being also slightly curved anteriad at the middle, making the entire cell appear curved instead of straight as usual.

Abdomen blue-brown above, the sixth, seventh, and eighth segments being faintly marked laterally at the base, by a triangular white patch and the posterior margins of all segments having golden-brown hairs; basal ventral segments white, apical ones dark, mottled brown; the bases of the fourth to seventh with a white band and abundant golden hairs; ninth segment pale, brown-ocher with golden pile.

Legs uniformly brown, except as noted; fore and mid femora dark-brown externally, golden-brown internally, basal half of hind femora pale-brown, nearly white, apical half dark-brown except a white, longitudinal dash under knees; all tibiæ dark-brown, spined; metatarsi very dark, almost blue-black, with basal, cream bands, most marked on posterior legs; first tarsals on all legs and most so on posterior, basally cream-banded, second tarsals on posterior also banded, other tarsals on all legs brown with faint band on second posterior. Ungues on fore and mid legs equal, unidentate; on posterior equal, simple.

♂ unknown, only two females having been captured, in act of biting.

NEGROS OCCIDENTAL, P. I., Volcano Canlaon, Mt. Siya-Siya, at altitude of 760 meters.

Time of capture, 24 June, 1906 (*Banks*, Coll.).

Type, ♀, No. 6083 in Entomological Collection, Bureau of Science, Manila.

I dedicate this beautiful species to the memory of Dr. José Rizal y Mercado in recognition of his work as the first Filipino scientist.

This species is very closely related to *C. japonicus* Theob., from which, however, it can easily be distinguished, by the thoracic adornment, the

THE PHILIPPINE

JOURNAL OF SCIENCE

VOL. I DECEMBER, 1906 No. 10

THE PHYSIOLOGICALLY ACTIVE CONSTITUENTS OF CERTAIN PHILIPPINE MEDICINAL PLANTS.

By RAYMOND FOSS BACON.

(From the Chemical Laboratory, Bureau of Science.)

INTRODUCTION.

The number of native plants used for medicinal purposes by the Filipinos is very great. Among this multitude of remedies it is desirable to know which ones are really valuable and which ones are worthless, and it is also important to isolate and study their active constituents, as such work may reveal substances valuable in pharmacology which hitherto have been unknown. It is also true that many plants are found in the Philippines which are closely allied botanically to well-known species which in other countries produce physiologically active substances, but the natures of which are as yet unknown to the native.

With such a vast field to choose from, it was considered advisable to adopt the following plan: A preliminary examination is being made as rapidly as possible of such plants as are reputed by the natives to have medicinal value, or of such as are known to be used in other countries. These preliminary experiments have included both chemical and physiological tests. In cases where a physiologically active substance can be isolated in a pure condition, and especially where large yield, accessibility, and easy separation render feasible the acquisition of quantities of these active chemical compounds, it is proposed to make detailed studies. It is expected that these investigations will include not only chemical work but also thorough physiological and practical medicinal tests, when these seem to be warranted.

The identity of Gruppe's ditaïn is very doubtful. Tavera states that the dose of it is the same as that of quinine; hence it could not have been echitamine, the principal alkaloid of *dita*, as this substance in comparison with quinine is exceedingly poisonous.

As to the important medical results obtained, I was informed, by a European physician who was stationed in Manila at the time of Dr. Pina's tests, that the testimony of cures, etc., was made in reply to a request for quinine from the provinces where malaria was raging in epidemic form. Quinine was considered too expensive, so that the rural inhabitants were given ditaïn, while at the same time a statement as to its efficiency in place of quinine was made. The above statement gains in probability in view of the physiological behavior of dita, which I have found to be not at all like that of quinine.

Later, more important researches on *dita* bark were made by Jobst and Hesse[7] and by Harnack.[8] Harnack claimed that there is but one alkaloid in *dita* bark, which alkaloid he called ditaïn, and which is not to be confused with the impure product of Gruppe. He claimed that ditaïn is really a glucoside because, after boiling with hydrochloric acid, it reduces Fehling's solution. Hesse found several alkaloids in the bark which he studied, namely, ditamine, echitamine, echitenine, and oxyechitamine. Of these echitamine was found to be present in largest amounts and was the most thoroughly studied. A number of salts were prepared and analyzed, the formula $C_{22}H_{28}N_2O_4 + H_2O$ being established. Harnack[9] replied to the work of Hesse and reasserted his claim that there is but one alkaloid in *dita* bark; and he maintained that his ditaïn was identical with the ditamine of Hesse. Gorup-Besanez[10] examined Gruppe's ditaïn chemically and succeeded in obtaining from it a small amount of a crystalline substance which was apparently an alkaloid, but the amount of the latter which he isolated was too small to admit of any further examination.

As the bark is quite easily accessible in the Philippines, I have obtained and am investigating a large quantity. It is of a yellowish-brown color and from 1 to 12 millimeters thick. The outer layer has a scaly appearance because of its longitudinal and transverse fissures and is not infrequently marked with small, black spots. The bark breaks with rather a brittle fracture and this makes it easy to powder when dry; it is odorless and of a bitter taste which varies greatly in different samples. Some lots are exceedingly bitter, but with others this taste does not develop until the bark has been chewed for some time. The outer bark is always much more bitter than the inner, corky layer; in fact many pieces of the latter are tasteless. The wood of the tree and the bark of young twigs are not bitter and contain no alkaloid.

In the air dry bark I found 15.2 per cent of moisture (determined at 105°) and 3.29, 3.14, and 2.67 per cent, respectively, of ash in three

[7] *Ann. Chem.* (*Liebig*) (1875), **178**, 49; *Ibid.* (1880), **203**, 144; *Ber. d. chem. Ges.* (1880), **13**, 1648.

[8] *Arch. f. Exp. Path. u. Pharmakol.* (1887), **7**, 126.

[9] *Ber. d. chem. Ges.* (1878), **11**, 2004.

[10] *Ann. Chem.* (*Liebig*) (1887), **176**, 88.

Experiment A.—Guinea pig of 210 grams: 1 cubic centimeter of crude extract, containing 0.01 gram of alkaloid, injected intraperitoneally. After four minutes the animal begins to tremble and apparently to lose control of the muscles supporting the head; after seven minutes it lies down, unable to move, after which several spasmodic respiratory movements follow. Dead in fifteen minutes.

Experiment B.—Guinea pig of 105 grams: 0.5 cubic centimeter of crude extract, containing 0.005 gram of alkaloid, given intraperitoneally; all the usual symptoms of asphyxiation follow, but the animal lives for forty-eight hours.

The physiological tests on pure echitamine hydrochloride which are reported below, show that the minimum fatal dose for a guinea pig of about 200 grams is 5 milligrams and that 0.01 gram kills an animal of this size in about sixteen minutes, the symptoms being exactly the same as those observed with the crude extract. Hence, I consider that Experiments A and B prove that practically all the physiologically active constituent of the bark has been extracted, and that this substance is the alkaloid echitamine.

THE ALKALOIDS OBTAINED FROM DITA BARK.

Ditamine.—Hesse[14] has given this name to the alkaloid which can be obtained by rendering the aqueous solution from the plant alkaline with sodium carbonate, and then shaking out with ether. The alkaloid is removed from the solvent by means of dilute acetic acid, which is then rendered alkaline with ammonia and the resulting solution extracted with ether. Hesse states the yield of this alkaloid to be 0.02 to 0.04 per cent, but from 10 kilos of the bark he obtained only 0.1 gram of ditamine; the other nine tenths of the alkaloid he believes to have been occluded by one of the resins. I have succeeded in obtaining only very small amounts of ditamine, the largest yield being 0.3 gram of alkaloid from 5 kilos of bark. I have not been able to separate ditamine from any of the resins. These facts, together with my physiological experiments on the crude extracts from the plant, and Harnack's repeated claims that the dita bark contains but one alkaloid, make it doubtful whether the bark contains the percentage of ditamine claimed by Hesse.

As deposited from ether, ditamine is a varnish-like substance, slightly yellowish in color. It is easily soluble in ether, benzene, chloroform, and alcohol. From all these solvents it separates in an amorphous condition. It is not very soluble in petroleum ether. Some ditamine was dissolved in a small volume of chloroform and to this three volumes of petroleum ether was added. The ditamine separates at once in flocks, but is not obtained in a crystalline form by this procedure. Solutions of ditamine in the solvents mentioned above were very slowly allowed to evaporate for some weeks in the cold storage, but no crystals were obtained.

Concentrated sulphuric acid dissolves ditamine, giving a red color, which on warming becomes more violet, but the color is not nearly as strong as in the similar test with echitamine. With concentrated nitric acid a blue, then a green color is

[14] *Loc. cit.*

PHYSIOLOGICAL EXPERIMENTS WITH ECHITAMINE HYDROCHLORIDE.

Experiment A.—Guinea pig of 208 grams: 0.05 gram of pure echitamine hydrochloride dissolved in 1 cubic centimeter of water, injected intraperitoneally. In two minutes there is great uneasiness with spasmodic contractions of the muscles of the ears and eyelids, followed very rapidly by violent twitchings of muscles of the head, the animal apparently becoming rapidly very weak. Violent convulsive spasms soon follow, the marked characteristic being the difficulty in breathing. The final stages show the usual gasping for breath as in cases of death by asphyxia. Death takes place in seven minutes.

Experiment B.—Guinea pig of 320 grams received 2 cubic centimeters of a 1 per cent solution of echitamine hydrochloride (0.02 gram) intraperitoneally at 10 a. m. After shaving the abdomen and preparing for the injection, the animal was returned to its cage, and after a few minutes the respirations were counted. The respirations were also counted at intervals after injecting the poison. The results of the experiment are tabulated:

Time	Respirations per minute.	Remarks.
Before injection	138	
After 3 minutes	111	Animal quiet very slight, infrequent, spasmodic contractions of muscles of ears and eyelids
After 6 minutes	115	
After 9 minutes	106	Twitchings are increasing in strength and frequency.
After 15 minutes	63	Twitchings generalized stronger, prolonged expiration.
After 17 minutes		Animal crawling uneasily about cage.
After 18 minutes	48	Respirations shallow largely abdominal.
After 21 minutes	30	Gasping expirations followed by prolonged interval
After 24 minutes		Convulsions for a few seconds, death

An autopsy exposing the abdominal and thoracic cavities after apparent death showed irregular, spasmodic contractions of both auricles and ventricles of the heart for over two hours after all respiration had ceased. Intestinal peristalsis was still active for one half an hour after the cessation of respiration.

Experiment C. Guinea pig of 230 grams: 0.01 gram of echitamine hydrochloride in 1 cubic centimeter of water, injected intraperitoneally. In six minutes the animal is very weak and trembling. It crawls with difficulty uneasily around the cage. There soon follows the stage of more profound intoxication characterized by repeated, brief, clonic spasms The breathing toward the end is very shallow and is almost entirely performed by the accessory (abdominal) muscles. Dead in eighteen minutes.

An autopsy made immediately after apparent death shows the lungs to be greatly congested. The heart has dilated and shows abortive auricular beats. The intestines are found still to exhibit strong peristaltic movements. The exposed heart continues to contract irregularly for about three hours, showing that this alkaloid is not a "heart poison," as has been claimed by some writers.

Experiment D.—Guinea pig of 245 grams: 0.005 gram of pure echitamine hydrochloride in 1 cubic centimeter of water injected intraperitoneally. The same series of symptoms as occur in Experiment B are observed but none of the stages are as violent. However, they are much more prolonged. The animal continued to be ill for about forty-eight hours, but then completely recovered.

general weakness, often accompanied by hallucination. With medium doses there is recovery in twelve to twenty-four hours, but there is usually a loss of memory and great confusion of ideas for many days afterwards. It is this effect which gives rise to the use of the drug by the Chinese for stupefying a victim whom they intend to rob.

The poisoning of enemies is not a very frequent practice among the Filipinos, but toxicological work has come to this laboratory, during the prosecution of which hyoscin was found in the stomach of the victim, it being very easily extracted because of its great solubility in ether. The dry leaf of the plant is smoked by the natives to stop asthma and is said to be very effective in many cases.

Datura alba contains hyoscin, hyoscyamin, and atropine, the first named amounting to over 90 per cent of the total alkaloids present. Hesse,[18] who obtained his material from eastern sources, has made a detailed investigation of this plant, and as there has been so much controversy on the alkaloids hyoscin and scopolin, I have considered it desirable to make a further study of *Datura alba*. In the air-dried leaves from Philippine specimens of the plant, I found 0.21 per cent of total alkaloids, in the seeds 0.465 per cent, and in the wood and roots (ground up together) 0.17 per cent. I can confirm Hesse's statements as to the properties of hyoscin in every particular.

The plant is a common weed in the Islands and might readily be used as a source of hyoscin, as two or three crops a year could easily be obtained. I expect to work out a cheap method of isolating the alkaloids from this plant with the hope of starting a small industry. Chemical studies of oscine, the decomposition product from hyoscin, are also under way.

CAESALPINIA SAPPAN Linn.[19] (*Leguminosea*).

This tree is encountered from British India to Malaya; it is also common and widely distributed in the Philippines. The Tagalog name is *sibucao*, or *sapang*. *Sibucao* is chiefly used as a dyewood, it being known in the English markets as sappan wood, and it is very popular among the Filipinos for dyeing the native fabrics. A decoction of the wood is also used in medicine, it being administered in cases of hæmorrhage, especially those from the lungs, the red color probably suggesting its use to check bleeding. The decoction has also been employed in cases of chronic diarrhœa, in which instances its efficiency is probably due to the tannin which it contains.

In some reference books the statement is made that sappan wood contains brasilin and, indeed, Bolley[20] identified this alkaloid in the coloring matter obtained from the wood. In view of its economic

[18] *Ann. Chem.* (*Liebig*) (1898), **303**, 149.
[19] Sp. Pl. (1753), 381; Baker in Hook. f. Fl. Brit. Ind., **2**, 254.
[20] *J. Prakt. Chem.*, **93**, 351.

importance in these Islands and because of inquiries made at this Bureau and at the Bureau of Forestry, it was considered advisable to confirm these statements.

As the roots are said to contain the greater percentage of coloring matter, 1 kilo of these were finely ground and then heated in a closed vessel, with water, for eight hours. The aqueous extract was filtered from the wood and evaporated *in vacuo* to a small bulk, whereupon an aliquot portion was desiccated, giving a residue of 2.7 per cent. The concentrated liquor was placed in the cold storage for two weeks, when a reddish, crystalline crust had been deposited. This was dissolved in 12 per cent alcohol containing a little hydrochloric acid and zinc, filtered, evaporated and the brasilin recrystallized from strong alcohol.

The brasilin thus obtained was in amber-colored crystals, soluble in water, alcohol, and ether. With ammonia it gave an intense carmine, as it did with potassium or barium hydrates The solution in sodium hydrate, when decolorized with zinc dust, rapidly absorbed oxygen from the air and again became colored. With aluminum sulphate or with ferric chloride it gave purple, black lakes. Brasileïn was obtained as a brown, crystalline powder upon oxidation with nitric acid. The alkaline solution of brasilin, which had been turned red by oxidation in air, was again reduced to a colorless condition by the addition of hydroxylamine hydrochloride; on being acidified, the brasilin was regenerated. Fusion with potassium hydrate gave a small amount of resorcin, which was identified by color tests and by the melting point.

These tests, together with the results of Bolley's analysis, leave no doubt but that the coloring matter of sappan wood is brasilin.

ENTADA SCANDENS Benth.[a] (*Leguminosæ*) AND SOME OF THE FISH POISONS.

Entada scandens is cosmopolitan in the Tropics of the world. It is widely distributed and quite abundant in the Philippines. The Tagalog name is "*gogo*;" Visayan and Pampangan names are *bayogo* and *balogo*. The wood of the vine is cut into thin strips, which are then beaten between stones in order thoroughly to disintegrate the fiber. In this condition *gogo* is brought into the markets. It is largely used by the natives for washing the hair. To this end the prepared *gogo* is soaked over night in cold water; the red solution makes a very good lather which renders the hair very soft without making it too dry, as is usually the case with soap. Tavera states that this treatment cures pityriasis, and I have found this to be the general belief among Spaniards and the better class of natives. There is no question but that the people who wash the head with *gogo* and then apply coconut oil have very luxuriant hair, but whether this luxuriance is due to the use of this substance can not be stated. The natives also use *gogo* for treating the itch, washing the affected parts with the decoction and at the same time briskly rubbing them with the fibers. In this way they remove the crusts that shield the mites. The treatment is successful in direct proportion to the energy of the rubbing. The tough bark of this plant is used in Ceylon for cordage and fiber.

[a] Benth. in *Hook. Journ. Bot.*, 4, 332; Baker in Hook. f. Fl. Brit. Ind., 2, 287.

The physiological action of the saponins is very interesting, as all of these bodies are characterized by their great hæmolytic power; many are very irritating and many are true protoplasm poisons. The following represent typical cases of the action of saponin on animals:

Experiment A.—Guinea pig of 210 grams: 0.005 gram saponin in 1 cubic centimeter of water injected intraperitoneally. The animal was very uneasy soon after the injection. Trembling, labored breathing, and progressive weakness follow. Dead in two hours. An *autopsy* performed immediately after death shows the peritoneal cavity to be much congested, with large amounts of a bloody, serous exudate present. A microscopic examination of this fluid reveals great numbers of leucocytes, in clumps, the red blood corpuscles being dissolved and the serum deeply colored with hæmoglobin. In the heart's blood, the lysis was not so marked, but the serum was tinged with hæmoglobin. The lungs were normal. The minimum fatal dose of *entada* saponin intraperitoneally is 0.0025 gram for a guinea pig of 200 grams weight, although animals often showed dangerous symptoms with one fifth of this dose. Injected intravenously, saponin is much more poisonous, 0.0002 killing a rabbit of 800 grams weight in two minutes. Dr. Harry T. Marshall, of the Biological Laboratory of this Bureau, has made further physiological studies on this saponin and his results are reported elsewhere in this number of the JOURNAL.

FISH POISONS USED BY THE NATIVES.

Entada scandens is one of the plants used in the Philippines as a fish poison, and it owes its efficacy in this direction to its saponin content. A saponin solution of 1 to 20,000 was prepared, and three small fish placed in it. They soon became stupefied, floating about without motion on the top of the water, and all died within two or three hours. Controls under similar conditions were not affected.

Fish poisoning is much practiced by all the wild tribes in the Islands, and also to a considerable extent in the outlying districts by peoples who are classed as civilized. The fish poison is usually prepared with considerable ceremony by the head men of a village, the various ingredients being pounded up together and then thrown into the stream or pool. The plants are often mixed with earth and rocks, the intention being to sink the noxious plants so that all parts of the water may be poisoned. Very soon, small fish begin to float on their sides on the top of the water, while the larger ones move about slowly in a stupefied and helpless manner. The natives then rush into the water and kill and catch all they can, after which there is a great feast. Many of the ingredients put into the fish poison mixtures are harmless and without effect. Some of the important ones which we have thus far obtained are cited in the following:

One of the favorite poisons is "*túba*" or "*tañgan-tañgan túba*," which is the native name for the fruit of *Croton tiglium* Linn.[23] (*Euphorbiaceæ*). This well-known tree is widely distributed in the Philippines as a cultivated or semicultivated plant. Other native names for it are

[23] Sp. Pl. (1753), 1004; Hook. f. Fl. Brit. Ind., 5, 393.

being obtained. This liquid has a very astringent taste and is acid, 10 cubic centimeters requiring 6.22 cubic centimeters of $\frac{N}{10}$ sodium hydrate for neutralization.

The following experiments show its physiological behavior:

Experiment A.—Guinea pig of 210 grams: 1 cubic centimeter of expressed juice of the berries given intraperitoneally. Uneasiness and weakness almost immediately follow; the animal is dead on the next morning. An autopsy showed very pronounced local irritation in the abdominal cavity, also a bloody serum; the lungs and heart are congested.

Experiment B.—One cubic centimeter of expressed juice is rubbed on the shaved skin of a guinea pig. Evidences of considerable uneasiness appear soon afterwards. The next day a rash has become evident and the skin is dark and like a very brittle, rough leather.

A peculiar acid is present in the *Diospyros* fruits, which seems to belong to the tannic acid series, and to which I provisionally assign the irritating properties of the plant. With ferric chloride it gives a greenish-black precipitate and it is precipitated from strong solutions by dilute hydrochloric or sulphuric acid. Lime water throws down a greenish-black calcium salt. Gelatine forms a leather-like mass and albumin gives a precipitate. Lead acetate precipitates it to a slight extent, basic lead acetate completely. An alcoholic solution of thymol, followed by concentrated sulphuric acid which is run under the solution, gives a rose colored ring, or with the same acid added directly to the mixture, a turbid, rose-colored solution. The rigid proof that this tannic acid is the active principle of the plant will have to be brought later as much more work on it is necessary. It may be remarked that the extract of these berries alone makes a very fair ink, in which respect it might be compared to *Coriaria thymfoia*, the ink plant of New Granada and New Zealand.

TINOSPORA CRISPA Miers.* (*Menispermaceæ*).

This plant is widely distributed in British India and Malaya. The Tagalog name is "*macabuhay*." This word means literally "you may live," and it expresses the very general belief in the marvelous medicinal virtues of this plant. In the Philippines it is considered to be a panacea to be applied to all bodily afflictions.

The stem is the part employed in medicine, although in India, where the plant also has a great reputation, the leaves and roots are also used. The plant is officinal in the Pharmacopœia of India. It has been recommended by various physicians as a febrifuge and also for gout, for secondary syphilis, as a powerful emetic for snake bite, leprosy, chronic rheumatism, dyspepsia, and as a cure for insanity, while a necklace made of small pieces of the stem is worn as a remedy for jaundice. The above gives some idea of the wide range of diseases which *macabuhay* is supposed to cure. European physicians in the Philippines state that

*Contrib. 3, 34; Hook f. et Thoms. in Hook. f. Fl Brit. Ind., 1, 96.

The hard, smooth-coated seeds are exceedingly common in the Islands, the native boys using them in a game similar to marbles. They are purchasable at all the shops and are quite cheap, the price being 10 cents, United States currency, per pound, and all classes of natives consider them to be a good medicine for "stomach troubles." An adult will eat from ten to twelve nuts, and if there is no relief in an hour or two the dose is repeated, and the dosage for youths and infants is in proportion. Nausea and symptoms of poisoning are said to be produced when too many are taken. The kernels are also supposed to be very efficacious as an antiperiodic and tonic; in India a powder prepared from them and black pepper, ground together, has a considerable repute for the same purposes and as a febrifuge. The active principle of the nuts is supposed to be a substance termed bonducin, which was isolated by Heckel and Schlagdenhauffen,[48] who assigned to this body the formula $C_{14}H_{15}O_5$. I found that ten kernels weighed 9.8 grams; ten nuts 21 grams.

Several kilos of the nuts were obtained and examined. The taste of the kernel is exceedingly bitter. Dilute acids or acid-alcohol do not extract either alkaloid or glucoside, but there is about 20 per cent of a light-yellow, fixed oil in the seeds, which can be obtained in the usual manner by pressing or extracting.

One kilo of the finely ground kernels was extracted hot with alcohol with the aid of a reflux condenser. The alcohol was distilled and the oily residue dissolved in a small amount of chloroform. This solution was now washed successively with dilute alkalies, acids, and water, filtered, and then poured into 5 volumes of petroleum ether. The bonducin then separated as a white powder. This was filtered and purified by successive treatments with chloroform and petroleum ether.

Obtained in this way bonducin is a white, amorphous powder with a nut-like odor and a resinous feel and aspect. It has an exceedingly bitter taste which it lends to water, in which it is only very slightly soluble. It dissolves to a greater extent in dilute hydrochloric acid, but after the solution is boiled no reduction of Fehling's solution takes place, so that bonducin is not a glucoside.

It is readily soluble in chloroform and glacial acetic acid and in ether with but a slight residue; it is taken up by petroleum ether with very great difficulty. Strong alkalies slowly dissolve bonducin, as they do most resins. The substance gives a blue color with concentrated hydrochloric acid, which becomes purple on standing; the same reagent with a little ferric chloride gives a strong greenish-yellow; a salmon color is obtained with concentrated nitric acid, and concentrated sulphuric acid produces a brown, which soon goes to a deep purple. Bonducin from which all ether-insoluble matter has been carefully removed, gives an intense rose-red color with concentrated hydrochloric acid, instead of a blue as with the ordinary preparation.

Another method of obtaining bonducin is by extracting the ground nuts with ether; when the solvent has been evaporated, the resin separates from the oil as a white powder; this separation can be rendered more complete by adding petroleum ether.

[48] *Compt. rend. Acad. d. sc.*, Par. (1886), **103**, 89.

Various attempts were made to obtain bonducin in a crystalline condition or to produce a crystalline derivative from it. Solutions of the resin in different solvents were left in the cold storage for weeks without result.

The resin is not changed by boiling for one and one-half hours with 100 cubic centimeters of 95 per cent alcohol to which 10 grams of concentrated sulphuric acid have been added.

A different result was obtained with alcoholic potash.

Five grams of bonducin were boiled on a reflux condenser for one hour with alcoholic potash On pouring into water, nothing separated. The aqueous, alkaline solution was now extracted with ether and on evaporation this solvent left 2.1 grams of a brown resin. Both of the resins behaved much alike, giving the usual color reaction excepting with concentrated hydrochloric acid, which produces no color with either, and with nitric acid, which gives the salmon color only with the acid product. It was not found possible to obtain a crystalline derivative from either resin.

All the properties of bonducin show that it is a resinous mixture, the nature of which it would probably be exceedingly difficult to elucidate. It is obvious that no formula can be assigned to it.

A solution containing one part of bonducin to 1,000 parts water and which is exceedingly bitter was prepared for physiological tests. It has no effect when injected into guinea pigs. Amœbæ were suspended in a drop of this solution for three hours without showing any change in their movements. The appellation of the "poor man's quinine" which is given to *bonduc* seeds in India would therefore not seem to be very applicable.

PLANTS CONTAINING PURGING OILS.

Plants of this class are numerous in the Philippines. I have examined *Aleurites moluccana* Willd.,[44] *Aleurites trisperma* Blanc. and *Jatropha curcas* Linn., all of the *Euphorbiaceæ*, the nuts of which have the reputation of containing efficient purging oils. Thus, Tavera mentions the use of the oil of *Aleurites moluccana* by Dr. O. Roche, in doses of 1 to 2 ounces, and states that Doctor Xerez, municipal physician of Sampaloc, has had frequent occasion to employ the oil. The chemical properties of the two *Aleurites* oils are being studied by others in this Laboratory. I have investigated the seeds with the view of isolating the constituents of the oil which might be physiologically active, as I hoped to obtain a toxalbumin similar to abrin, ricin, or crotin.

Many attempts to isolate such a substance from the seeds of *Aleurites moluccana* were made.

[44] Sp. Pl., 4, 590; Hook. f. Fl. Brit. Ind., 5, 384.

Habitat: Eastern India to southern China, Malaya, northern Australia, and Polynesia, naturalized in tropical America; widely distributed and abundant in the Philippines. Native name, *lumbang*.

The crushed seeds were freed from their oil, either by pressing or extracting with ether. The seed cake was now extracted with 10 per cent sodium chloride, in the cold, the solution being kept sterile by means of a little toluol or chloroform. It was then filtered and the albumins separated by saturation with ammonium sulphate, the precipitate being then collected and dialysed until free from sulphates,[45] the dialysed solution being usually prepared of such a strength that 1 cubic centimeter corresponded to 1 gram of seeds.

The solution gives pronounced reactions for albumins. Two cubic centimeters will kill a guinea pig of about 200 grams' weight in about twenty-four hours; boiling the solution for two minutes destroys the toxic power. When evaporated *in vacuo* over sulphuric acid, a white powder remains which also gives tests for albumins, but this powder is not toxic.

The albumin in the solution can also be precipitated by alcohol, but in a nontoxic form. Very many experiments were made in an attempt to obtain the toxin in a more concentrated condition, but all were unsuccessful. All the solutions used in these experiments were sterile. The results of the work on a large number of guinea pigs and rabbits, which was carried out with Dr. Strong, Chief of the Biological Laboratory,[46] would seem to indicate that the seeds of *Aleurites moluccana* contain a toxalbumin which is either unstable, or present in minute amount, or only very moderately poisonous.

Injections of 1 cubic centimeter of the oil of *Aleurites moluccana*, both subcutaneously and intraperitoneally, into guinea pigs of about 200 grams, weight had no effect; neither did the acids produced by saponifying the oil and given in doses of one cubic centimeter behave differently. Negative results were also obtained when 1 to 2 cubic centimeters of the oil were ingested by these animals, although this latter quantity is over ten times the dose given by Dr. O. Roche. The oil which I used was carefully prepared and neutral, so that, if it were active, the results could be attributed to it and not to the acids or other substances which might be present in the commercial article.

Similar experiences as regards a toxalbumin were found after a study of the seeds of *Aleurites trisperma*.

Jatropha curcus Linn.[47] (*Euphorbiaceæ*) is a native of tropical

[45] In all my dialyses I have used collodion tubes prepared according to the method of Gorsline. (Contributions to Medical Research, dedicated to Dr. Vaughan by his students, Ann Arbor, Mich. (1903), p. 390.) I can recommend them very highly. The speed of dialysis is very much greater than with parchment paper, and the tubes are quickly and easily prepared. I have found that the collodion sack slips off from the glass tube over which it is prepared very easily if, just before dipping the glass tube in the collodion, one rubs over it a little soap suds, which are then wiped off with a towel, so as to leave a thin, invisible coating of soap on the glass.

[46] I wish to express my thanks to Dr. Strong for his interest in this work.

[47] Sp. Pl. (1753), 1006; Hook. f. Fl. Brit. Ind., 5, 383.

America, and is now distributed throughout the Tropics, being common as a hedge plant in the Philippines. The native names are *tuba*, *casla*, *tava-tava*, *tawa-tawa*. It is widely used in the Philippines as a purgative; in fact many natives do not distinguish between the seed of this plant and the castor bean. As a matter of fact, the oil is strongly purgative, and the seeds are even more so, so that one of the latter is an ample dose, and three will cause dangerous symptoms. The oil is present in the seeds to the extent of about 25 per cent, and in the latter I have found a substance which behaves like a toxalbumin. If it proves to be such, Dr. Strong has kindly consented to take up its study. Robert and Siegel [48] claimed to have found such a substance in *Jatropha curcus* fruits.

I have made arrangements with Dr. W. E. Musgrave, of the Biological Laboratory, whereby he will make a study of these purging oils. We hope to be able in the future to state what substances are the active principles of these oils. It has been noted previously that they are rather uncertain in their action, behaving as if an accidental mixture might cause the purging.

[48] *Bull of Pham* (1893).

saponins is very different from that of serum, the former being comparable rather to that of the alkaloids where only a loose and transitory union is effected between the cell and the chemical agent.

The hæmolytic action of saponin was studied by Ransom (8). He found slight quantitative differences in the action of saponin on blood from different species. Lysis occurs more rapidly with concentrated saponin and blood than it does when either is diluted. Saponin becomes bound both to the corpuscles and to the serum, 0.75 cubic centimeter of either fixing 2 milligrams of saponin, so that it does not subsequently act on red corpuscles. He found that this action depended upon cholesterin, and obtained the same result with pure cholesterin dissolved in lecithin, lecithin alone being inert. One cubic centimeter of a 1 per cent solution of cholesterin in ether was added to 20 cubic centimeters of a 0.1 per cent solution of saponin in 0.85 per cent salt solution, shaken and kept at 36° for a few hours. At the end at this time the saponin-cholesterin mixture exerted no action on dog's blood and had no local irritating action when placed under the skin of frogs.

From his examination of corpuscles undergoing hæmolysis, Ransom thinks that saponin acts first upon the surface of the corpuscles, later upon the interior. Kobert, however, classes saponin as one of those substances which most readily penetrates the corpuscles.

Ransom's work was confirmed by Schanzenbach (10), who also found that injections of saponin lower the resistance of animals to the action of bacteria.

Attention has been turned to the hæmolytic action of saponin and to the similarity of the interaction of saponin and cholesterin to that of toxin and antitoxin.

Both Bashford (1) and Besredka (2) failed in their attempts to produce an immunity in animals inoculated with saponin, thus contradicting the claims of Pohl, and Sachs (9) explains the action of cholesterin by assuming that it acts only as a solvent for the saponin. However, it would be difficult to understand why saponin previously dissolved in cholesterin should be any less injurious to corpuscles than the saponin alone. Madsen and Noguchi (6) studied the cholesterin-saponin combination by the methods of physical chemistry and were able to plot a curve for the interaction of these bodies similar to the curves obtained for various toxin-antitoxin mixtures.[1]

[1] Since this article has been in press a work by Bunting (*J. Exp. Med.* (1906), 8, 625-646) has been received. Bunting studied experimental anæmias in rabbits. To produce anæmia he used saponin "which is intensely hæmolytic to rabbit blood in the test tube, and to which, apparently, a tolerance is not so easily established" (as to ricin). The fatal dose was 1.5 to 2 milligrams per kilo of animal. Injections of sublethal doses were followed by slight changes in the leucocytes,

No immunity could be demonstrated in rabbits or guinea pigs previously treated by intraperitoneal doses of saponin or of a saponin-serum mixture, although differences were observed in the susceptibility of the corpuscles of different animals of the same species.

Amœbæ from dysenteric patients and from tap water are destroyed by saponin. After a few seconds in a solution of a strength of 1 to 400 the amœbæ burst with explosive suddenness, the ectosarc disappearing, the granules flying in every direction, and only traces of the nucleus remaining, surrounded by a few coarse granules. When more dilute saponin is used, amœboid activity increases for a few minutes; the amœba then becomes more or less circular, while undulations pass around the periphery, where the clear space enlarges, both centrally (forcing the granules close around the central nucleus) and peripherally, the total diameter increasing. The granular endosarc seems to be walled in by an inner membrane of the ectosarc, the increase in the size of the amœba occurring between the two layers of the ectosarc. As the size increases, amœboid motion diminishes. After a short period, varying with the concentration of the saponin, a change suddenly takes place in the endosarc; the granules become larger, stream into the clear, swollen ectosarc and fill the whole body of the amœba as far as the limiting membrane. A few seconds later the amœba either explodes in all directions, or, more commonly, bursts through a pseudopod-like projection, which suddenly appears.[2]

It was at first thought that a simple physical explanation might be found for the bursting of the amœbæ. The property which saponins possess of holding solids in suspension so that they can not be separated by filtration has already been mentioned. It was thought, perhaps, that saponins would also remove ions and dissolved substances from a solution, perhaps holding them in colloidal suspension, in which case a simple osmotic pressure theory of the bursting of amœbæ could be developed. For, as the saponin is not readily dialyzable, its power of removing dissolved substances from the system (amœba and solution) would be confined to the solution outside of the amœba. Hence, because of a resulting change in osmotic equilibrium, water would rush into the amœba, in which organism more dissolved substances would be present than in the outside solution, until the ectosarc of the amœba would be ruptured explosively. The experiments to decide on the value of this theory show that it is not the true explanation, and that the latter will probably need to be sought in a specific action of the saponin, possibly on the extosarc, corresponding to the theory of the action of saponin on blood corpuscles as given by Stewart (12).

[2] A similar action of neutral red upon amœbæ has been observed by Dr. W. E. Musgrave.

complex. In the first place, the older sedimentaries were profoundly folded and probably also much faulted; in the second, erosion set in and truncated many of these folded beds; in the third, subsidence occurred and a coralline mantle was laid down upon these truncated folds, and in the fourth, the whole region received a thrust from below in which elevation took place, but it was an unequal elevation, with tilting east, west, north, and south. The north and south tilt, which, however, may be decidedly more recent than the east and west one, is best seen in the vicinity of Argao, where the marine terraces incline to the north at an angle of about five degrees.

Mr. Becker[7] has remarked upon the even sky line of the central part of the island and explains this as resulting from the peculiar growth of coral reefs, which grow up to a limiting plane, the surface of the water. This is undoubtedly correct, and the coralline mantle has suffered but little tilting in the region of the *Cordillera*. In the lower regions the even sky line is still well preserved in many places, but the tilting is marked.

Since my return from the field, Mr. Bailey Willis's brief discussion of his physiographic studies in Europe, appearing in the Carnegie Yearbook,[8] has suggested to me possible explanations for some of these phenomena, for which a ready solution did not seem to be at hand, and the Carpathian type of mountains, with their peculiar physiography, namely, folded Neocene strata subsequently tilted and warped with sink holes, seems to find an analogy in Cebu.

Mr. Willis also emphasizes the fact that the *growth* of mountains is distinct from the existence of mountains by virtue of their structure. I am inclined to think that those of Cebu have *grown* rather than that they are due to inherent structure, for were it not for the great subsequent erosion, one might start from the coast and climb toward the *Cordillera* without being aware of anything more than a moderate ascent, for it is the afterwork of the streams which has made Cebu appear to be mountainous. The photograph on Plate II shows what this work has been; indeed, the similarity of this region to the Benguet country of northern Luzon is quite marked, although in reality its elevation is from 2,000 to 3,000 feet less.

Extended sections are rare, but one in Butuanon Creek was photographed, showing the local warping in the Pliocene limestone. We believe this phenomenon to be quite widespread over Cebu. (Pl. III.)

[7] Becker, G. F.: Geology of the Philippine Islands, *U. S. G. S. 21st An. Rep.* (1902), 561.

[8] Bailey Willis: *Fourth Year Book,* Carnegie Inst. (1905), 106.

HANGING VALLEYS.

The phenomenon of hanging valleys is not by any means common in Cebu, but there are two or three quite remarkable examples. One is found on the west coast, in the vicinity of Barili, where there is a beautiful waterfall of about 50 meters, and another, much more typical, in the Guila-Guila country where the Bocanit drops off the upland country into the valley of the Mananga, some 250 feet below. (See Pl. IV.) The outcrop near the top of the wall is a limestone, very rich in *Orbitoides*. The underlying rock is igneous; although the higher valley is still young, there is a marked difference between the cross sections of the two, the upper one being more on the order shown by fig. 1.

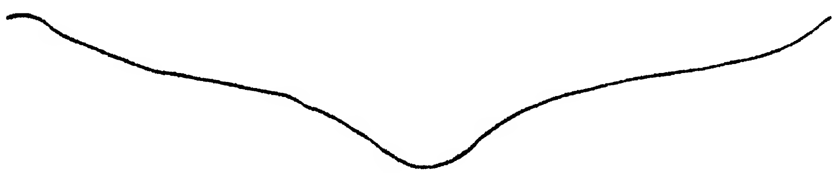


FIG 1

The lower one is a typical cañon, and is diagramatically sketched in fig. 2.

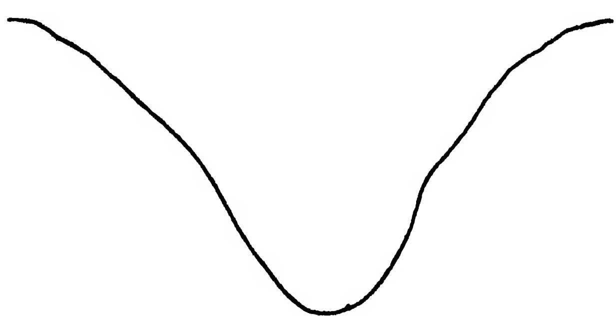


FIG 2

We need not believe in any unusual series of events, other than a rather rapid rate of elevation, to explain this phenomenon. Evidences of elevation are abundant throughout the whole length of Cebu, as has been pointed out by Becker, Abella, and others.

Another factor might be suggested as having played some part in producing the great difference in these two valleys, namely, the quantity of water available for the work of erosion on the plateau and in the

deeper valley. The country rock underlying the highlands is limestone, abounding in sinks and cracks, so that meteoric waters do not gather so well into streams and hence do not become available for degradational work. On the other hand, the lower stream taps all or at least a large part of the underground water from the overlying formations, besides gathering the contributions from the higher stream itself.

The photograph (Pl. V) shows the cañon-like appearance of the Mananga just below the point where the Bocanit enters, and also the men at work constructing the new Cebu-Toledo road and the difficult nature of this work. In the Philippines it is absolutely imperative that the roads should be built well above the highest water of these mountain streams and also high enough so that the rock on the upper slopes shall be reduced to a minimum.

In referring to this phenomenon of hanging valleys Salisbury[a] has spoken of the two streams as being *out of topographic adjustment.* This lack of topographic adjustment always points to some disturbing influence, is due to many divers causes, and is exhibited in various forms. The hanging valley is nearly always an attendant phenomenon in glaciated mountainous regions. I do not find any other reasons for supposing that there has ever been any glaciation in Cebu, while I do believe the explanation which considers perfectly normal events to be sufficient in this case.

The uplands do not support as large a population as one would suppose to be the case and in many portions, chiefly in the central ones, the natives live huddled in squalid barrios or reconcentration camps. Corn is the principal product, but even this crop is cultivated in a sporadic, half-hearted, and primitive way, nature being relied on to do the larger part of the work. Plate VI is a view of typical upland country in the region of the Compostela-Carmen coal fields.

THE COVES ("CUENCAS" OF ABELLA).

The best land on the island of Cebu is to be found in the valleys of such streams as the Pandan, Jacupan, Carmen, etc. These meander through beautiful, broad, flat-bottomed valleys, which are very much like those of East Tennessee and North Carolina in the United States. They are generally flat bottomed, the level of the valley floor being usually not over 50 meters above the sea, they are often roughly circular in outline, and in nearly every case the stream which occupies the valley issues from it through a narrow, cañon-like cut in an igneous formation which acts as a barrier. A diagram, as follows, will probably convey a better idea of the relations pertaining in these valleys:

[a] Salisbury, R. D., and Chamberlin, T. C.: Geology, New York (1904), 1, 154.

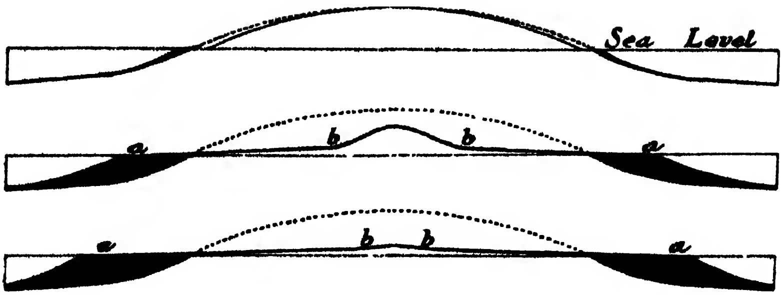


FIG. 4.—Diagrams to illustrate the effect of rain erosion on an island when all the eroded material is deposited about the shore The black portions represent deposition The dotted lines represent the original surface The several diagrams represent successive stages in the process (After Chamberlin and Salisbury)

It is seen from these figures that while there is a shifting of material from the highlands to the sea-border, there is no diminution in the bulk of the mass, but only a change in its form. It can also be seen that the portion between the levels of high and low water approach more nearly a true plain, for along this belt the waves, tidal or otherwise, are continuously at work levelling down any irregularities. Beginning from here, in either direction, toward the shore or toward the sea, the profile departs greatly from the horizontal. If the island were gradually to subside, the water would encroach on the land and the waves would tend to plane off the latter, carrying the horizontality of the profile curve farther and farther inland. If, on the other hand, the islands were rising, the plain would grow seaward and there would be little change in the upper portion of the profile.

Now, if we suppose that reefs are forming around the island, which is rising at the same time, the growth of this platform seaward would be greatly quickened. Coral reefs make ideal foundations upon which to build a plain, because they grow up to a limiting level, namely, the surface of the water. When the coast becomes sufficiently elevated to bring these reefs above the water, we already have a flat surface which usually has a very slight slope toward deep water. At the edge of this coral platform the slope is very sudden and very great, though just at the edge the reef is slightly higher, the result of wave action, no doubt. For the most part the coastal plain of Cebu is of this origin. This is well seen by an examination of the plain north of the city of Cebu, just west of Mabolo, and in the neighborhood of Mandaue.

Rivers build many parts of typical coastal plains in the form of delta deposits. The best example of this class of formation which Cebu affords is probably the one at Argao. A delta deposit may be distinguished sometimes by its triangular shape and always by its peculiar cross section in which two series of beds can be seen. In the lower portion of a section of sufficient depth the layers are seen to dip at rather high angles, whereas

above these lies a series which is more nearly horizontal, or to be exact, which has the same gradient as the stream itself. The streams, as elevation continues, will be engorged in their old deltas, while they build new ones farther out to sea.

MANANGA RIVER.

The Mananga is typical and, as an example, will be discussed separately. A critical physiographic study of this river from its source in the *Cordillera* to the sea, is most instructive. It is selected because it is easily reached from the city of Cebu, and it presents nearly all the features of interest pertaining to the other streams of the island.

Where it rises in the region of the *Cordillera* the declivity is at a maximum, and therefore the numerous tributaries are short, comparatively straight, and join the main stream at right angles. The latter is oriented north and south, because it follows the syncline in the limestone. In this part of its course it is a structural stream. Its valley is broad and shallow, in striking contrast to the conditions in its lower course.

At the boundary between the older limestone and the igneous formation, the stream swings sharply to the east and makes its tortuous way across to the younger limestone. In traversing the igneous formation it flows at the bottom of a deep and narrow cañon, winding back and forth to avoid the harder phases of the volcanic rock, which within short limits varies greatly in physical and chemical composition. In this portion of its course the Mananga would be called an antecedent stream—that is to say, it keeps the general direction it had when it was on the limestone which overlies the igneous rock. In the former part of its course it was a *consequent* stream, flowing to the east as a *consequence* of the slope of the formations. Having become well intrenched, it worked down to the basement rock or became superimposed upon it, without having its general direction changed.

When the Mananga finally leaves the igneous rock it again becomes a *consequent* stream. In this lower portion its valley once more widens to a very broad, fertile, cove-like area, the valley of Jacupan. A local change in the character of the limestone formation, which being largely coral sand becomes very soft, and the occurrence of marl deposits account for this.

Still farther down we come to the gravel and sand plain near the sea, where the once vigorous and eroding stream is sluggish as it passes across old, dead, coral shelves finally to dip into the Mactan Sea. In no portion is the Mananga navigable even for bancas. In fact, this lack of depth is true of all the streams of the island, the condition principally being due to lack of sufficient feeding ground to support large streams, to limited plain country, and to the character of the rocks. The lack of certain classes of vegetation offers an added factor. The absence of even one good, navigable stream connecting the coast with the interior produces a profound difference in the economy of the people.

a large range, to borrow a biological term, because each one procures his or her own daily subsistence. This oftentimes necessitates miles of roaming on sea and land. Just as this fact has led to conflicts in the past, and still causes them in the lower animals, so it will to-day in the higher communities. Example after example might be given where whole groups have become extinct because of these factors, but one will be sufficient. In Jurassic times in North America there lived the great and strange group of mammals known as the Dinosaurs—these were of such prodigious proportions and required such extensive ranging grounds (they were both herbivorous and carnivorous) that they became a menace to themselves. They disappeared because of their very unwieldiness, their own strength and power finally working toward their downfall.

The trouble in Cebu is largely economic, and is a result of material causes. Physical factors such as I have outlined are deep seated and have been at work before governments and human laws were instituted. Naturally, the solution of the problems presented in this island lies in the reduction of the individual range, in division of labor, in putting into motion the host of units, human and material, now unorganized and idle. There is no danger, as it was once thought, that the community of interests, the introduction of machinery, etc., will cause some to be pushed to the wall in the economic struggle.

With these will come new vocations, not known before, and they will be largely industrial, thus leading the native out into ever-widening circles of experience and larger and larger spheres of influence.

To accomplish these things it will not be necessary for him to leave his natural home, but he must study the things about him -- the topography of his country, that he may control economic conditions; the streams, with a view to utilizing their water power; the strata of the earth, to mine from them mineral wealth; the soil, that he may get the most from his crops.

With economic conditions in a settled state, and that means a healthy state—the social and political phases will settle themselves.

ILLUSTRATIONS.

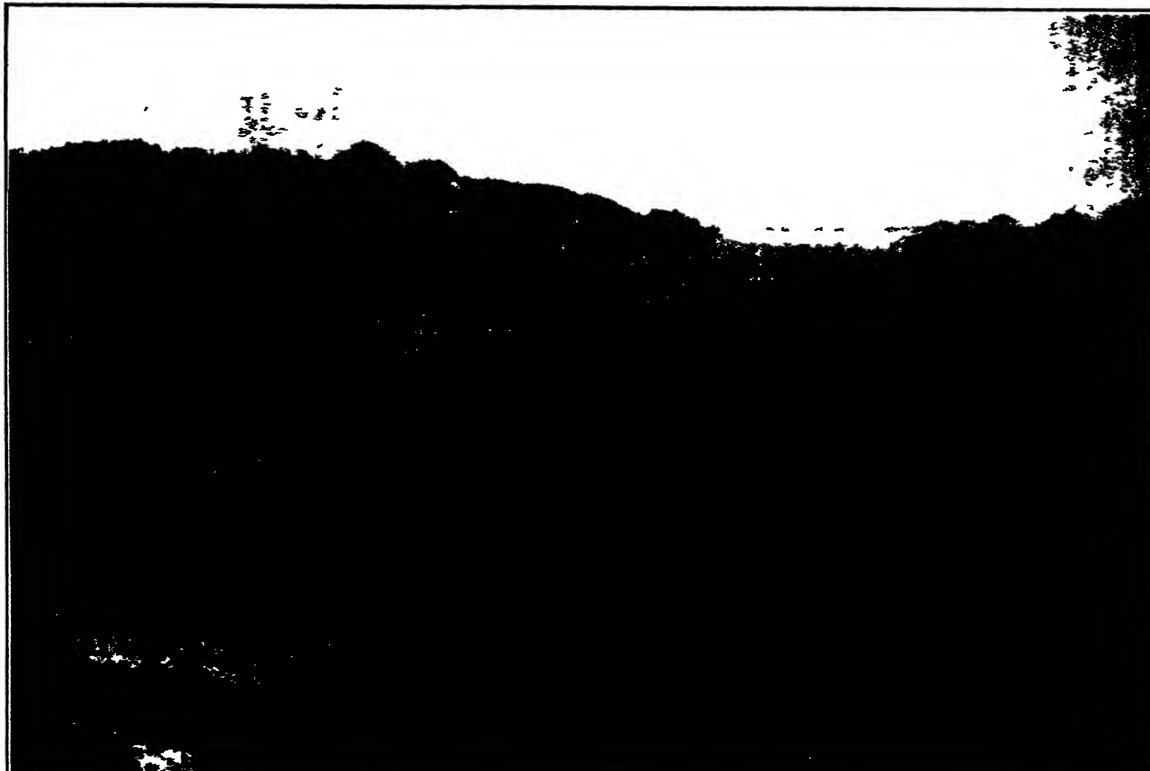


Photo by Smith

PLATE VI

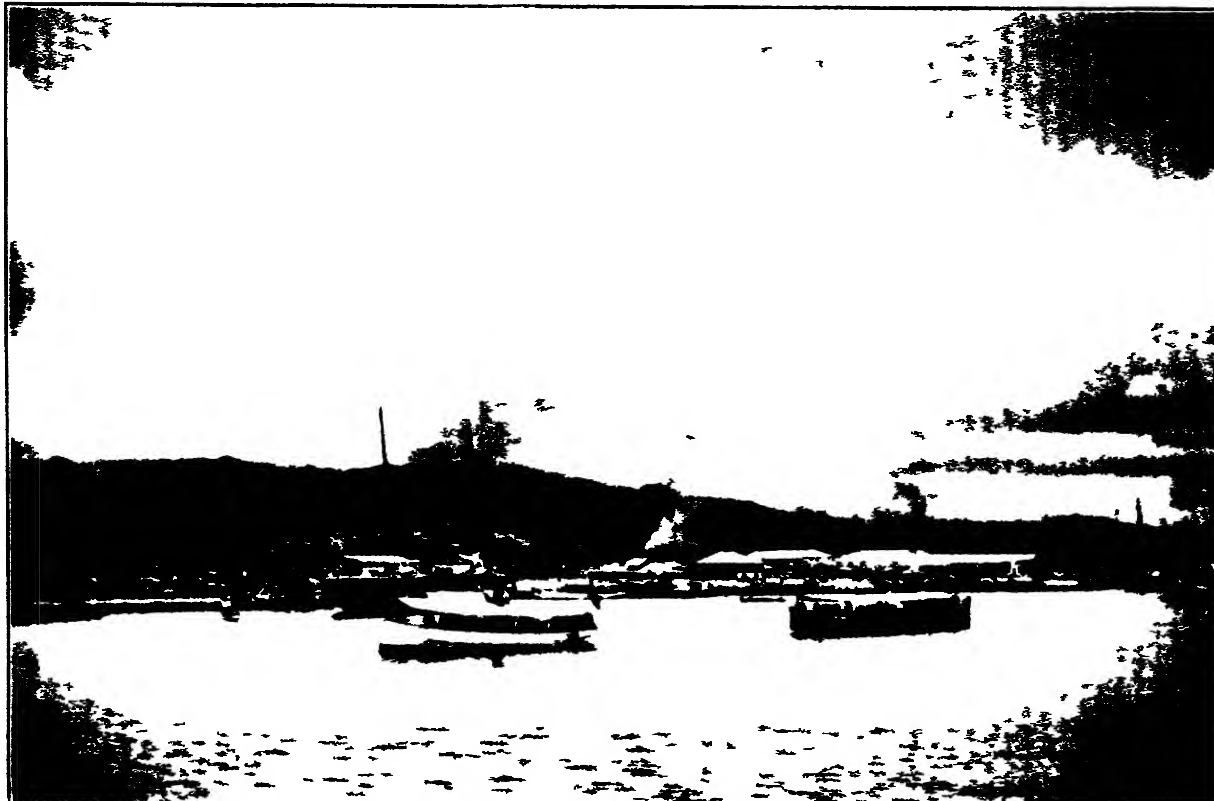


PLATE V

AGENESIS OF THE VERMIFORM APPENDIX.

By Harry T. Marshall and Ralph T. Edwards.[1]
(*From the Biological Laboratory, Bureau of Science.*)

Variations in the size, shape, and position of the cæcum are not particularly uncommon, though usually these lie within narrow limits.

Differences in position, length, and mesenteric attachment of the appendix are very common. It is usually stated that the length averages from 5 to 8 centimeters, the extremes being between 1 and 33 centimeters. According to Treves, four general types of appendix and cæcum are encountered; these depend in part upon the shape of the appendix and in part upon the degree to which the development of the lateral terminal sacculus (haustrum) of the cæcum exceeds that of the mesial terminal sacculus. The right sacculus is the larger in nine out of ten subjects.

According to Gegenbaur, the embryonic cæcum develops unevenly; one part develops fully and forms the adult cæcum, while the growth of the terminal portion is arrested at an early stage, leaving a conical tube terminating the cæcum at the time of birth. This is the condition described by Treves as the fœtal type of appendix. Gegenbaur apparently considers this the normal condition in the new born, the narrowing of the appendix and the development of the right haustrum of the cæcum occurring subsequently. Quain states that in the great majority of cases these changes begin before birth, and this is the prevailing view. The embryogeny of the cæcum and appendix was carefully studied by Kelly and Hurdon (1) in the series of human embryos collected by Professor Mall and Mr. Max Brödel at the Johns Hopkins University. The cæcum first appears at the fifth week of fœtal life as a slight swelling near the most anterior portion of the intestinal loop. A transient process, like the vermiform appendix, appears at the lower end of the cæcum as a bud, sometimes showing a cavity continuous with that of the gut. This structure disappears about the eighth week, leaving no trace. The true appendix develops as an extension from the primitive cæcum, having the caliber of the latter. About the seventh or eighth week a primary differentiation occurs into a large, proximal pouch and a smaller distal one. The diminution from the larger to the smaller

[1] Read before the Manila Medical Society October 1, 1906.

agenesis of the appendix, but with a case in which the usual arrest of development did not occur in the appendicular portion of the embryonic cæcum.

We have been able to find only one other example in more recent literature. Ferguson (3) mentions, without comment, the fact that in his series of 200 dissections, congenital absence of the appendix was noted once.

Ellsworth Eliot (2) reported a case operated on for recurring attacks of pain over the ileo-cæcal region. A fibrous cord, free from smooth muscle and surrounded by fat, was the only trace of appendix found. Dr. Stafford, of the Civil Hospital, informs me that he and Major E. C. Carter had a similar case not very long ago.

The specimen here described came from an adult, male Filipino dead of cholera. There was no abdominal scar, nor were there other deformities; the peritoneum was free from adhesions; only the lower end of the cæcum was free, the mesenteric attachment extending nearly to its tip and almost up to the point of union of the three longitudinal muscle bands. There was no trace of an appendix. The longitudinal bands in the specimen united at a point on the posterior, inferior surface of the cæcum to the mesial side of the axis of the cæcum. At this point there was a small, papular elevation about 6 millimeters across and about 2 millimeters high which was the only rudiment of appendix to be found. It is to be noted that below the ileo-cæcal junction there was one large cæcal pouch on the right, or lateral aspect, which was partially subdivided into four shallow haustra, and one smaller haustrum on the left, or mesial aspect of the cæcum. On the lower end of the ileum opposite its mesenteric attachment there was a free fold of mesentery containing a little fat, corresponding to the embryonic meso-appendix, or ileo-colic fold. This was removed in preparing the specimen and only its attachment to the ileum is visible in the illustration. On opening the hardened specimen, a few circular folds of mucosa were seen surrounding a shallow depression corresponding to the orifice of the appendix. Sections show that the mucosa has dipped down to occupy this depression. The dip in the mucosa can be followed in serial sections as a gland-like tube, which runs diagonally through the mucosa of the cæcum, bends sharply on itself, passes through the submucosa, and ends abruptly after penetrating rather less than half way through the circular muscle of the cæcum. At the point of origin, where its dimensions are greatest, the invagination measures 6 millimeters by 3 millimeters, the size decreasing to its tip. In structure it consists of a tube of mucous membrane presenting many simple glands, having the structure of the crypts of Lieberkühn, and rich in mucous cells. Between the glands are many lymphoid follicles. Surrounding the mucosa is loose, connective tissue quite abundantly supplied with vessels. Van Gieson stains show that the rudiment has no muscle coat. The muscle fibers of the cæcum are separated partly

by the small tip of the rudimentary appendix with its submucosa, but these muscle fibers are definitely part of the circular muscle of the cæcum. There is no evidence of inflammation in the sections.

SUMMARY.

In this case, which presented no signs of inflammation of the peritoneum, and showed no other congenital anomalies, there was no appendix visible on external examination of the cæcum, and on microscopic examination only a rudimentary structure could be found, which extended as a shallow invagination of the mucosa of the cæcum from its lumen, to end between the fibers of the circular muscle of the cæcum. The latter was subdivided into four shallow haustra. The rudimentary structure showed only mucosa, and no muscular or peritoneal coat of its own. It is interesting that the ileo-colic fold remained.

From the features here summarized we regard this case as an example of agenesis of the appendix.

LITERATURE.

(1) Brewer, G. E.: Intussusception of appendix vermiformis. *Am. Med.* (1905), 9, 67.

(2) Eliot, Ellsworth: Three unusual cases of appendicitis. *Med. & Surg. Rep. of the Presbyterian Hosp.* in the city of New York (1898), 3, 173

(3) Ferguson, John: Some important points regarding the appendix vermiformis. *Am. J. of Med. Sci.* (1891), 101, 61.

(4) Kelly & Hurdon: The Vermiform Appendix W. B. Saunders & Co, Phil. & Lond. (1905).

(5) Schridde, Herm: Ueber den angeborenen Mangel des *Processus vermiformis. Arch. f. path. Anat.* Berl. (Virchow's Arch.) (1904), 177, 150-160.

it will have bored through several nodes and have found lodgment in the third joint from the top or near the ground. The adult of this insect has not been reared.

CORN AND SORGHUM INSECTS.

Both of these plants are attacked to some extent by the rice army worm, but corn has a special enemy in the form of the stalk borer (*Pyrausta vastatrix* Schultze, MS.). Sometimes as many as three or four of the larvæ are found in the same cornstalk. Plants so attacked seldom bear fruit.

Sorghum, with which cultural experiments are being carried on at the experiment station here, is affected when in bloom by a tiny, unidentified Cecidomyid, the female of which lays as many as twenty or thirty eggs in a single spikelet. Last year the seed production of the plants was lessened as much as 80 per cent by the ravages of this insect.

COCONUT INSECTS.

Being one of the chief industries in the Philippines, the cultivation of coconuts when menaced by insect attacks assumes a discouraging aspect. There are not many very serious pests found upon this very useful tree, but those that do attack it bring about the most sinister results. Its principal enemies are the rhinoceros beetle (*Oryctes rhinoceros* Linn.), the Asiatic palm weevil (*Rhyncophorus ferrugineus* Fabr.), and the transparent scale (*Aspidiotus destructor* Sign.).[a] It has been found that the only effectual means of contending with these pests is constant vigilance to prevent their entrance into a plantation and, when present, to rid the trees of them before they can do serious damage. Clean cultivation, together with moderation in the matter of removing dead leaves from coconut trees, has proved the most effective mode of procedure in this as well as other coconut-growing regions.

SUGAR-CANE INSECTS.

This staple Philippine product is exceptionally free from insect attacks other than that of locusts. One species of stalk borer (*Aphodius* sp.), a beetle, which, as larva and adult, gives occasional trouble in the Island of Negros, and a species of Aleurodid, are the only pests worth mention in this connection. Our greatest energy with reference to this plant will be used in the prevention of possible future importation of infected "seed" cane from regions such as Hawaii, where the sugar-cane leaf hopper (*Perkinsiella saccharicida* Kirk.) has done so much damage.

[a] For a full account of these insects see *Phil. Journ. Science* (1906) 1, 143–165 and 211–236.

INSECTS AFFECTING DOMESTIC ANIMALS.

Aside from fleas, in the case of dogs and cats, and a species of louse (Lipoptera=Mallophaga) of the carabao, our domestic animals are comparatively free from parasitic insects. True, the various species of horseflies (Tabanidæ) and *Stomoxys calcitrans* Linn., are rather abundant at certain seasons, but they are not as annoying to animals as similar species in the United States, and flies like the horn fly (*Haematobia serrata* Desv.), the horse bot (*Gastrophilus equi* Fabr.), and the ox warble (*Hypoderma lineata* Villers) are, so far, unobserved here.

MYIASIS AND HUMAN PARASITISM.

During my work here one or two very severe cases of human myiasis have come under my observation. In one case the flies were identified as *Lucilia dux* Esch.

The ordinary house insects, such as the bedbug (*Cimex lectularius* Linn.), the house fly (*Musca domestica* Linn.), (*Musca* spp.), the head louse (*Pediculus capitis* De Geer), the crab louse (*Phthirius inguinalis* Leach), and the flesh flies (*Sarcophaga* spp.) are all abundant, but the natives usually have their remedies for those which give them bodily discomfit, while they completely disregard flies of all kinds, even mosquitoes, as a necessary and therefore bearable evil.

MOSQUITOES.

No one single problem in economic entomology, in so far as its relation to human well-being is concerned, develops such large features as that of the limiting of mosquitoes.

Up to the present time there have been recorded from the Philippine Islands 83 species [a] belonging to this family.

Work on yellow fever and malaria in the United States and on the latter disease in India, Italy, Africa, and elsewhere has shown, more or less accurately, the species of mosquitoes which play a rôle in the transmission of these diseases. No work has as yet been done in the Philippines showing which of the 17 species belonging to *Anophelinæ* are the carriers of malaria. This field of research, which has been unexplored here because of pressure of other and routine work, will be entered into as soon as a way is seen whereby some of the ordinary routine can be given over to others, and it is not too much to suppose that some interesting developments will be had.

Filaria have been already demonstrated in at least one species of mosquito in the Philippines, namely, *Culex fatigans* Wied., but as this work is to be published at no late date, nothing further in regard to it will be included here.

[a] Banks: A list of Philippine Culicidæ, etc., *Phil. Journ. Sci.* (1906) 1, 977 et seq.

Many data have already been gathered with reference to the life histories of Philippine mosquitoes, and a series of publications looking toward the eventual monographing of forms found here is part of my program for the near future.

When more is known in this regard, we can the more successfully plan and execute preventive campaigns against these insidious foes of mankind.

USEFUL INSECTS.

SILKWORMS.

Of the work that has been done on useful insects, principal mention might be made of experiments looking to the introduction of silkworms into the Islands.

As far back as 1593 attempts were made by one of the early Spanish priests, Padre Antonio Sedeño, to introduce the silkworm into the Philippines, he having brought the mulberry and the "seed" here from China. Again, in 1780, Padre Manuel Galiana made a second endeavor but without success, save that plants from some of the original mulberry trees are still to be found in Manila and the Provinces of Tarlac and Batangas.

In spite of the fact that silk growers claim a temperature of more than 25° C. as injurious to the silkworms, our experiments both in the laboratory and in the field have proven that an excellent grade of silk can be obtained.

Our chief care will be as to the best method or keeping the eggs from the time of laying to hatching, but we hope to solve this by the use of a mild degree of cold in cold storage, facilities for which are now to be had in the chief towns of the Archipelago.

BEES.

Up to the present little attention has been given to bees in these Islands. There are at least three wild species which are found in considerable abundance throughout the Archipelago: *Megapis dorsata* Fabr., *M. zonata* Smith, and *Apis indica* Fabr., with *A. nigrocincta* Smith and *A. unicolor* Latr., which by some are considered mere varieties.

Of these, it is doubtful if *Megapis dorsata* Fabr., will ever submit to domestication. *Apis indica* Fabr., has already been kept successfully in hives and does fairly well, considering the fact that no scientific cultural methods have been followed.

There is no reason why American or Caucasian bees would do otherwise than well in the Philippines, although two attempts at importation on the part of a private individual have proven failures, owing to improper care of queens and brood in transit.

A rather inauspicious augury for the raising of bees here is the fact that the bee moth (*Galleria mellonella* Linn.) is very abundant and

The two most important and widely distributed Philippine bamboos are the common, thick-walled variety (*Bambusa blumeana*), and the thin-walled dwarf bamboo, also known as *caña-boho* (*Bambusa lumampao*). The former is almost exclusively used for building purposes, because of its strength and durability; it is grown as a crop along the river bottoms of Pampanga Province and in many other regions; cuttings are set out in rows 2 to 3 feet apart and merchantable sizes are produced in from one to two years.

Dwarf bamboo is the variety in general use throughout the Islands for the manufacture of the *sauale, quisame,* and *amatong*, which are woven products used for lining or filling the walls, ceilings, floors, doors, and shutters of nipa houses. This bamboo is found almost entirely within the forested regions and forms one of the most damaging influences to forest growth, it being almost as undesirable as clearings. In parts of Bataan Province immense tracts of this plant are annually cut and rafted to the market. This species is never cultivated.

"*Caña-boho*, probably *Bambusa lumampao*, is a characteristic form on the Lamao forest reserve. The clumps are composed of 15 to 20 culms, 12 to 18 meters in height and set on an average of 3 to 4 meters apart; not infrequently these clumps grow so close together that it is difficult to wedge a way between."[8]

CHEMICAL COMPARISON WITH OTHER GRASSES.

The fibers of graminaceous plants exhibit a certain resemblance in form and appearance. Manifestly, papers made from these substances should possess very similar properties. The grass-like character of bamboo is further shown by the similarity of its chemical composition with that of other grasses; this will be understood by a study of the following table:

TABLE I

Constituents	Bamboo.[8]	Wheat straw.[9]	Rye straw.[9]	Structural bamboo.[10]	Dwarf bamboo.[10]
	Per cent	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*
Cellulose	50.13	46.60	47.69	58.94	55.75
Fat and wax	78	1.49	1.93	.96	1.08
Aqueous extract	10.56	5.07	9.05	4.98	4.69
Noncellulose or lignin	24.84	28.49	26.75	24.25	21.27
Water	8.56	9.85	11.88	12.40	11.20
Ash	5.13	5.50	3.20	8.47	6.08

[8] H. N. Whitford: The Vegetation of the Lamao Forest Reserve. *Phil. Journ. Science* (1906), 1, 386.

[9] Hugo Müller: *Pflanzenfaser*, Leipzig (1873).

[10] Analyses made by Mr. Mariano Vivencio of this laboratory. It is also advisable to compare the above analyses of bamboo with those of the perennial grasses, esparto and cogon, given on page 458 of *Phil. Journ. Science* (1906) 1.

PREPARATION OF PAPER CELLULOSE FROM BAMBOO.

The procedures employed for obtaining paper cellulose from esparto and the cereal straws are applicable to bamboo as well. Because of the great solvent action of alkaline solutions, comparatively little pains are necessary in the preparation of bamboo for the digestion process. First, there is no bark to be removed, as in the case of the dicotyledinous pulp woods; fresh, mature stems need simply to be chipped, or better, cut in suitable lengths and crushed by passing between heavy, fluted rollers.

The quantity of alkali required to produce a well-boiled pulp from mature stems of the above-mentioned species of bamboo we have found to be 15 to 20 per cent caustic soda, calculated upon the gross weight of the material digested, which concentration yields from 40 to 50 per cent of a light-brown fiber, which has a clean and soft appearance suitable for wrappings, news, and book papers.

This consumption of alkali is not greater than is frequently necessary in practice for cooking esparto grass,[11] and other graminaceous plants, such as the cereal straws, which are so largely employed in Europe for fine paper stock. These require from 10 to 15 per cent of caustic soda to yield 33 to 37 per cent of pure fiber.

On the other hand, the commercial pulp woods used in the production of soda fiber demand a much greater proportion of alkali for their complete resolution; the amount of caustic soda employed in practice, in making soda wood pulp can only be approximated. It is customary to add sufficient liquor of a known strength to cover the chips, and this volume depends of course upon the state of division of the wood, the thoroughness with which it is packed or tamped down, and the form of boiler employed. Griffin and Little give 700 gallons of liquor per cord of wood when rotary boilers are used, and a much larger volume in case stationary, upright digesters are employed. One thousand gallons of liquor, carrying 7½ per cent caustic soda (the average strength employed), would contain about 284 kilos (625 pounds) per one cord of chips, but the weight of a cord of pulp-wood chips is very indefinite. Its approximate weight may be deduced indirectly, by knowing the amount of pulp a cord of wood will yield and the average percentage yield of pulp from a given wood by the soda process.

454.5 kilos (1,000 pounds) of pulp is considered an average yield from one cord of poplar wood. The average percentage of yield of wood pulp by the soda method of treatment may be given as 40 per cent. Thus 454.5 kilos of pulp represent 1,136.3 kilos (2,500 pounds) of wood, and one cord of wood (1,136.3 kilos) consumes 284 kilos of caustic soda, or 25 per cent, calculated on the gross weight of the wood.

The above calculation demonstrates that mature bamboo is much more easily resolved into paper fiber than is the most generally used wood employed for the manufacture of paper pulp by the soda process.

[11] See footnote No. 5, page 437 of *Phil. Journ. Science* (1906) 1.

PRELIMINARY PREPARATION OF BAMBOO FOR DIGESTION EXPERIMENTS.

At first the outer, silicated rind and the nodes or joints of mature culms were digested separately, but it was found that the latter yielded to alkaline treatment with the formation of very little shive, but with a less cellulose content than when internodes alone were used. The yield of pulp on the nodes and rind, respectively, was 35 per cent, as compared with one of 42 per cent on internode wood alone, under the same conditions. This deficiency is fully accounted for by the larger amount of mineral matter deposited in the joints and on the exterior surfaces of the mature bamboo stems.

All experiments in this direction showed that in practice the joints or nodes, if well crushed, would offer no resistance to caustic soda liquors and that it would not be necessary or even advantageous to effect any preliminary sorting between the different portions of the stem, hence in the recorded experiments no separation was practiced. Bamboo pulp, similarly to straw and grass fibers, shows a tendency to roll up into little balls under slow motion, so that rotary digesters would probably prove unsuited to this raw material.

EXPERIMENTAL PART.

All of the digestion and bleaching experiments tabulated below were made on 454 gram lots (1 pound) of air-dried material. The bamboo chips or sticks were packed into an upright digester, variable quantities of caustic soda liquor, in all cases sufficient to cover the chips, were added, and the heating was done by direct flame.

TABLE II.

STRUCTURAL BAMBOO (*Bambusa blumeana*)

Conditions of digestion	Experiments.					
		II	III	IV	V	VI
Strength of liquor per cent	10	10	7½	7½	8½	6½
Amount of caustic soda calculated on the weight of the material digested per cent	22½	20	17½	15	20	12½
Time of boiling hours	9	5	5	5	5	5
Pressures employed atmospheres	6	5–6	8	6–7	8	6–7
Yield of pulp:						
Unbleached per cent	41.75	42	42.55		42.7	43.1
Bleached do		10.2	40.6		39.4	
Amount of bleaching powder consumed per cent	22.85	21.7	23.9		24.8	
Loss of weight in bleaching do		4.4	4.6		7.9	
Color	Yellow.	Cream.			Poor white	

TABLE II—Continued.

DWARF BAMBOO (*Bambusa lumanpao*).

Conditions of digestion.	Experiments. I	II.	III.	IV.		VI.
Strength of liquor .... per cent	10	10	7½	7½		6¼
Amount of caustic soda calculated on the weight of the material digested .... per cent	22½	20	17½	15	22½	12½
Time of boiling .... hours	5	5	10	5		10
Pressures employed .... atmospheres	8	5-6	6-7	6-7	5-6	6-7
Yield of pulp:						
Unbleached .... per cent	44.05	45.6	47.22	49.1	46.33	50.4
Bleached .... do	41.4	42.6	-	43.7		
Amount of bleaching powder consumed .... per cent	9.9					
Loss of weight in bleaching .... do	6.1					
Color	Cream.	Light cream.		white		

The experiments outlined above bring out the following considerations:

First. Dwarf bamboo is superior to the structural variety both in yield of unbleached pulp and in consumption of bleaching agent.

Second. Caustic soda in the proportion of 10 to 20 per cent, calculated on the gross weight of the canes, is sufficient to produce a well-digested pulp.

Third. The duration of the digestions and the pressures and corresponding temperatures carried are considerably less than are employed in pulping the common, soft woods by this process, and compare very favorably with those used in practice for straw cellulose manufacture.

Fourth. The structural bamboo requires excessive quantities of bleach (20 to 25 per cent) to produce at best a poor white, while the dwarf variety, on the other hand, is bleached a good white with the equivalent amount of powder consumed by annual and perennial straws, namely, 10 to 20 per cent.

PALM FIBERS.

Several species of the other *Palmeæ*, including rattans, betel-nut palm (*Areca catechu*), nipa palm (*Nipa fructicans*), buri palm (*Corpha umbraculifera*), and coconut palm (*Cocos nucifera*), are found widely distributed throughout the Archipelago and contribute to the local demands of the people for food and fiber.

The *bejucos* or rattans, which occur so plentifully throughout forested regions, are used principally for the manufacture of furniture, and they are far too valuable to be otherwise primarily employed. The various pieces of furniture into which rattans so largely enter are constructed entirely of this material and dwarf bamboo, so that old or worn-out

by-product of a large and rapidly growing industry, and as this fact assures their availability in almost unlimited quantities, they are worth considering from the standpoint of their applicability for paper or pulp manufacture.

Lengthy experimentation with coconut husks has shown that the fibers can not economically be separated from the cellular matter in which they are embedded, at least not by caustic alkalies. A treatment sufficiently drastic to remove this nonfibrous matter not only causes too great an expense in the chemicals involved but seriously attacks the fibers themselves; furthermore, this class of fiber is not amenable to bleaching processes.

For the production of pulp for purposes other than paper this material appears both cheap and admirable. As a substitute for wood pulp in the manufacture of various commodities such as roofing and felting materials, in which case a complete removal of the corky layers is not necessary or advisable and where bleaching is not required, the husks could be prepared by mechanical means alone or by mechanical means followed by a mild alkaline treatment. In the dry state in which the husks come to the consumer they are easily roughly cleaned to form a tow-like mass of fibers, which greatly resembles oakum, and which represents from 40 to 60 per cent of the gross weight of the husk, depending upon the quantity of corky matter still adhering to it.

In those countries where coir fiber is an article of commerce, the husks are first crushed between heavy, fluted rollers, then passed through the extractor, which consists essentially of a cylinder covered with steel teeth which tear the fiber from the husk, and then a subsequent winnowing removes the short fiber and dirt.

Buri palm.--This palm is second only to the coconut palm in the variety and usefulness of its products. The tree is never cultivated, but it grows luxuriantly in a wild state in many sections of the Islands. The Recoleto estate in southwestern Mindoro contains hundreds of thousands of individuals of this species. One of the principal uses of this palm is to furnish material from which mats and sugar sacks (*bayones*) are made. The leaf is the only part suitable for these purposes. The long leafstalk, which contains abundant structural fiber, is employed for making fine hats and coarse ropes and twine. Throughout Panay, where this palm is widely distributed, it furnishes practically all the cordage fiber in use. Good-looking rope is made by beating the fresh, green leafstalks until the fibers are partially separated, and then, after drying, these are twisted into cordage of various sizes.

Only *coconut husks*, which were taken to represent the class of fiber to be obtained from any palm fruit-pericarp, and *buri palm* rope fiber, which was considered to typify the class to be obtained from the leafstalks of all palms, were studied.

ILLUSTRATIONS.[15]

PLATE I.

FIG. 1. Structural bamboo (*Bambusa blumeana*).
2. Dwarf bamboo (*Bambusa lumampao*).

PLATE II.

FIG. 1. Coir fiber (*Cocos nucifera*).
2. Buri-palm fiber (*Corpha umbraculifera*).

[15] Photomicrographs by Martin. Fibers seen longitudinally.

C